JUN 5 1940

SIGMA XI QUARTERLY

VOL. 28 SUMMER, 1940 NO. 2

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Published at Burlington, Vermont, by the Society of Sigma Xi

ANNUAL SUBSCRIPTION $1.00 SINGLE COPIES 25 CENTS

Change of address of chapter members and associates should be communicated to chapter secretaries and to the National Secretary.

Subscriptions should be sent to the National Secretary, George A. Baitsell, 187 College St., Burlington, Vt., or Yale University, New Haven, Conn.

Manuscripts should be sent to the National Secretary at New Haven, Conn.

Entered as second-class matter at the Burlington, Vermont, post office under the Act of March 3, 1879. The SIGMA XI QUARTERLY is published at 187 College St., Burlington, Vt., Spring, Summer, Autumn, and Winter.

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THE FICKLE IQ*

BETH L. WELLMAN

This address is on a theme arising out of research investigations in which I personally have been engaged for nearly fifteen years, the theme of the changes in intelligence made by children under differing environmental conditions. This theme has been of interest to others in the Child Welfare Station as well. It is almost impossible for me to discuss my own work in this area without recognition of the work of some of my colleagues at the Station, particularly Dr. George Stoddard and Dr. Harold Skeels. It so happens that the work of each of us has supplemented and confirmed that of the others to a remarkable degree. As a result we are in effect an informal committee bound together by a common interest. In giving my own version of the general problem this evening, I take full responsibility, but hope that my version does not do too much injustice to their point of view.

At the present time the problem of how much change in IQ can be brought about by changing environmental conditions is the hub for a bitter controversy. The word "bitter" is used advisedly, since some of the Iowa findings have evoked strong emotionally-tinged language from certain quarters. These persons admit that they are smarting under the publicity given to our findings and to their educational implications. Alert newspaper reporters have added to this discomfiture by giving their own version of our speeches. One such reporter from a Washington, D. C., newspaper published an account of one of my talks before a technical society, under his own colorful title "The Wandering IQ." A psychologist countered with an article entitled "The Wandering IQ. Is it Time for it to Settle Down?"

On the other hand, there are educators who tell us that the results are what should have been expected all along. Lay persons, too, are interested and write to us. Some ask for information, and some know all the answers and write to set us straight. Certain technical psychologists, also, are upset. Life for the investigator in this field at the present time is indeed not boresome!

Yet our results are not unique nor extraordinary. There is a substantial amount of confirming material in the technical literature. We do have the benefit of a large mass of evidence from various angles, and we have been able to demonstrate more extreme amounts of IQ change than hitherto reported,

* An address before the Iowa Chapter.

partly because we have been fortunate enough to study children for whom more radical shifts in environmental conditions have been made. It is my purpose tonight to give a general overview of our findings and not to burden you with detailed analyses of sub-points, which are of course a necessary part of complete scientific knowledge. For various reasons, I shall touch upon only a few of the implications of the results.

The interest of the Child Welfare Station in mental growth of children dates back to its very beginning. When in September, 1917, the Station opened its doors, there was begun that month a series of mental and physical measurements of school children, under the supervision of its first director, the late Bird T. Baldwin, who was interested in consecutive measurements of the growth of individuals over a period of years in each of these areas, and in the interrelations between mental and physical growth. Four years later, in 1921, with the opening of the University preschool laboratories, the measures were extended downward to begin at two and three years of age.

As a graduate research assistant I participated in this program and later as a staff member took over certain portions as a responsibility. The chief intelligence measures used were revisions and adaptations for American children of the scale originally devised by the Frenchman, Alfred Binet. We had been told by the author of one of these American revisions that a child could be expected to maintain his same relative position throughout the childhood years. If a child were examined at one age and reexamined several years later, his IQ (that is, intelligence quotient) would be approximately the same, within rather narrow limits determined by errors of measurement. If he were classified as average in intelligence on one examination, he would almost certainly be average on a subsequent examination. If he were superior on first examination, he would again be superior. To be sure, the manifestations of intelligence would change with progress in age, but his position within a group would remain the same. In other words, the IQ would be constant.

Inspection of our records of consecutive measures on Iowa City children convinced us, however, that such was not actually the case. Casual inspection revealed wide fluctuations on reexamination. At that time we had no reason to doubt the general premise that, given an adequate measuring instrument, the IQ should remain the same. Therefore, we began a preliminary analysis with the intent of showing that the Binet scale was not a suitable instrument for use in repeated measurements on the same individuals. As analysis progressed, however, the changes were found to be more systematic than we had first thought and generally in the direction of gain. Groups of children who attended our preschools and University elementary school made mean gains of as much as twenty IQ points, resulting in a major change in classification. It became apparent that these changes were not random or chance changes; they seemed to be connected with the type of environment the children were experiencing in the interim. Thus we came to make our first major analysis on the preschool group, arriving at the conclusion that preschool attendance was bringing about systematic gains in intelligence.

Over a period of more than fifteen years we have been laboriously piling up records of changes in IQ associated with attendance at our University pre-

school laboratories. We now have records covering changes over one academic year, with an average interval of six months between fall and spring tests, for 652 children two to six years of age on initial measurement. These 652 children were in daily attendance at our preschool laboratories. They were a superior group when they entered preschool, having a mean IQ of 116.9. At the end of the academic year they showed a mean gain of 6.6 IQ points. These children, superior in intelligence on entrance to preschool, classified as a group very superior at the end of one preschool year.

A number of checks have been made to determine whether the changes are directly associated with preschool attendance or the result of extraneous factors. Some of these checks will be indicated here. *First,* these same children did not gain over the summer vacation months. We have such records on 432 children. Their mean change in IQ over the summer was a loss of 1.5 points, an insignificant difference. *Second,* the gains were cumulative over two years of preschool attendance. We have records on this point on 228 children. Over their first academic year they gained 7.0 IQ points. Over the summer vacation they lost 0.4 of a point, while over the second preschool year, they made an additional gain of 3.8 points. The net gain from the first fall to the second spring was 10.4 IQ points. The mean IQ on entrance to preschool was 117.3, or superior, and their mean IQ after two years in preschool was thus 127.7, or very superior. *Third,* non-preschool children (children who never attended preschool) did not make these gains. *Fourth,* cultural status of the parents of the preschool children did not account for their gains. Children from different occupational and educational levels of parents made similar gains when in preschool. *Fifth,* gains were shown not only on one scale, but on a variety of other measures. The *sixth* check had to do with a type of children usually showing the least benefits from regular preschool attendance; namely, those already extremely high in intelligence. An appropriate educational program experimentally applied to a small group of such extremely superior children appeared to affect their intellectual growth. Their changes in IQ were compared with a carefully matched control group. In this particular study, an interesting pair of twins was included. The twins were like-sex and very similar in physical appearance. At the beginning of the experiment they had duplicate IQ's, both very superior. At the end of the study which extended over one academic year, the experimental twin experiencing the special educational program tested 18 points higher than her control twin. *Seventh,* gains from preschool attendance appeared to be reflected in school achievement during the elementary school years. Children who had formerly attended preschool made significantly higher school marks in the first four grades of public school than former non-preschool children who at three years of age had been their equals in intelligence. The groups in this comparison were small, but the results were internally consistent. The last four conclusions or checks are based upon the work of the following graduate students: Mr. Hubert Coffey, Mr. Boyd McCandless and Mrs. Jean Kounin.

The results so far discussed were based on superior groups of children living in superior types of homes and attending our University preschools. Through the offices of Doctor Skeels as state psychologist for the institutional children of

Iowa, we were able to extend our studies of preschool age children to an underprivileged group residing in an orphanage. The orphanage superintendent had become cognizant of the fact that they were not providing adequate educational experiences for the younger children. Doctor Skeels suggested the introduction of a nursery school. Receptive to the idea, but not entirely convinced that this was the best means of meeting the needs of their particular situation, the orphanage superintendent proposed building a preschool unit, sufficient to take care of half their children, and a trial period. This afforded a rather unique opportunity for a research investigation. Consequently, a three-year study of a number of aspects of development was planned by staff members of the Child Welfare Station, including Doctors Stoddard, Skeels, Ruth Updegraff, Harold Williams and myself.

All available children of preschool ages in the orphanage were paired off into two groups, a preschool group to be in regular attendance in the preschool several hours a day, and a non-preschool group, to live the customary life provided by the orphanage. At the beginning of the experiment the two groups were closely matched on the following variables: IQ, age, sex, length of previous residence in the orphanage and nutritional status. It will be noted that the extra-preschool environment was the same for the two groups. During the hours of the day when not in preschool, the preschool children lived in the same cottages as the other children, they ate meals together and they slept in the same dormitories. Thus variables other than the one under specific investigation (namely, attending preschool for several hours a day) were fairly well controlled, considering the complexity of the lives of human subjects.

When we began the investigation our expectation was that the preschool children would probably increase considerably in IQ while the non-preschool children would probably maintain about the same IQ. That was not what we found. Instead, there were marked losses in IQ by the control (that is non-preschool) children. None of us had appreciated how very meager and barren the orphanage environment was, how greatly a barren environment could damage mental development nor what the effect would be on the preschool children of the mixture of this with several hours a day in the more enriched preschool environment. Yet when we examined into the non-preschool environment, it became evident that the children were being deprived of most of the experiences that are common to children of these ages who live at home with their own parents. Briefly, these children lived in so-called "cottages" with thirty to thirty-five other children of the same age, under the supervision of an untrained matron, assisted by one or two older orphanage girls assigned to the work without reference to their interest in younger children or aptitude with them. These persons were responsible for bathing the children, dressing them, looking after their toilet needs, getting them washed and combed for meals, and mending their socks and clothing. Play equipment and materials suitable for young children were practically non-existent either indoors or outdoors. No one to read to them, to tell them stories, to point out interesting things, to take a personal interest in an individual.

At the beginning of the experiment, both groups were somewhat below average in intelligence, the mean IQ being 82, or dull normal. The changes in IQ

for the higher portion of the two groups are of particular interest. The preschool children initially testing 80 IQ or above who were in residence 400 days or more did not change in IQ. Their initial mean IQ was 91.6 and their final mean IQ 92.1, a difference of 0.5 of a point. The control children at these levels who were in residence for the same length of time, 400 days or more, decreased markedly in IQ. Their initial IQ was 89.9 and their final IQ 73.7, a mean loss of 16.2 IQ points. Since an IQ of 70 or below is usually considered as indicating feeble-mindedness, it can be seen that the control group, with a final mean of 73.7, was not far above this division line. Since some individuals who initially tested average decreased through successive stages to feeble-mindedness, and were subsequently transferred to an institution for the feeble-minded on the basis of supplementary material in addition to test IQ, and since this phenomenon was peculiar to the control group and did not exist in the preschool group, we ventured to suggest that some children may be made feeble-minded by environmental conditions.

To summarize briefly our findings at the preschool ages, we believe that we can say that intellectural development is directly and seriously affected by educational experiences inside and outside of preschool.

The second major area of investigation has been the development of intelligence during early childhood, or the elementary school years. Here, again, our results were surprising to us as well as to others. We began these studies with an interest in the question "How permanent are the effects from preschool attendance? Is the accelerated IQ maintained or does it drop again to its former level?" For this purpose we obtained measurements at regular intervals on all former preschool children who were readily available for remeasurement. Our first analysis of results over a four-year period was published in 1934. Many of the children attended the University elementary school. For those who did we found an additional gain beyond that made while in preschool, amounting to 5.6 IQ points over a four-year period. But when we examined the change made by children who attended schools other than the University school, we found no such gain. At the end of the four-year period, this group had the same mean IQ as at the end of preschool. This led to the hypothesis that the type of educational experiences in elementary school was somehow related to tempo of intellectual growth. In both groups, it will be noted, the answer to our original question was that the acceleration in IQ brought about by preschool attendance was retained at least during the next four years.

Extraneous factors that might conceivably affect the differences in results from the different elementary schools were checked, among them the following: (1) Practice effects from frequent repetition of the test. To check on this, children were compared who had exactly the same number of tests over the same length of interval, but differing educational opportunity. (2) Intelligence at the time of entering elementary school. To check on this children were compared whose IQ's at the end of preschool were the same. (3) Responsiveness to environmental influences. To check on this, children were compared who had been entered in preschool at the same age and who had made equal gains while in preschool. All three of these checks operated simultaneously

in the groups compared. These factors did not account for the differences in gain during the elementary school years.

Four graduate students contributed additional information on this general problem of differences in mental growth associated with different school environments—Mrs. Josephine Roberts, Miss Elizabeth Starkweather, Miss Phyllis Haslam and Miss Ruth Brandenburg. Children in an elementary school connected with a teachers' college in a large city of another state were studied as were also children enrolled in the school system of an industrial suburb of the same city. All children in these school systems who were average or above in intelligence when they entered kindergarten or first grade and who had been continuously enrolled in the same school system were retested after an interval of five or six years.

Marked differences between schools were found in the pattern growth over this five- to six-year interval. In the one school system, the one located in the industrial section, there was no change in mean IQ. In the teachers' college elementary school, there was a slight mean gain, three IQ points. In the University elementary school there was a substantial gain, 7.1 IQ points. The children in the teachers' college represented a group very similar to the University school population in cultural status of parents and ability on school entrance.

Further questions investigated were: (1) whether the gains made in the University elementary school were peculiar to the children who had previously attended preschool; that is, whether an impetus was gathered from preschool attendance which carried the children on to further gains, and (2) how long such gains continued; that is, whether a stopping point was reached at some period in the children's growth.

To answer the first question, the children were divided into two groups on first enrollment in the University elementary school: (a) those who had attended preschool and (b) those who had never attended preschool. The non-preschool children enrolled in the University elementary school were first tested at the age of six years, at which time they had a mean IQ of 114.7, classifying them as superior in the general population. On retest at the age of ten years, they were found to have gained 11.2 IQ points, having then a mean IQ of 125.9, or very superior. The gains made by the non-preschool children were quite similar to those made by preschool children who were of the same intelligence levels at six years of age, with a tendency for the non-preschool children to make slightly greater gains than the preschool children. However, the total gain of the preschool children from the time of entrance to preschool to ten years of age was greater than the gain made by the non-preschool children. It was thus clear that both preschool and elementary school were contributing independently to IQ gain.

It was found further that the largest gain in the elementary school was made during the first two years, or from six years of age to eight years. The group studied attained a peak of 128 IQ at this age.

Some of our children have been followed through a period from preschool entrance at two or three years of age to college entrance. These records are piling up by the addition of new cases each University year. A preliminary

analysis was published two years ago of college entrance examination scores in relation to earlier mental growth, based upon twenty-one former preschool children and fifty-seven non-preschool children for whom long-time records had been obtained. The results appeared to indicate that college entrance examination scores were related to IQ at the preschool ages, and also to number of years spent in the University school system. Further, preschool children made higher scores on the college entrance examination than non-preschool children. We are continuing the investigation of this problem.

The general conclusion from this series of studies is that type of schooling is an important factor in growth of intelligence.

I should like to turn now to a brief discussion of some of the findings of Doctor Skeels and his co-workers. Skeels and Fillmore found that when whole families of children were admitted to the state orphanage, the younger children were brighter than their older brothers and sisters. Since this is a phenomenon not customarily found in random samplings of the general population, it became of interest to inquire into the causes of the relationship in the orphanage population. The orphanage children come from underprivileged homes, representing low economic status, low educational level of parents, often low mentality of the parents, poor condition of homes, lack of parental responsibility, and frequently presence of insanity and law-breaking activities by parents. Skeels and Fillmore postulated that the decrease in IQ with age in this group was a function of length of time spent in an unfavorable environment, that is, the longer the children spent in their underprivileged homes, the lower their IQ's became. The younger children, those eight years of age or below, had mean IQ's in the low nineties, representing intelligence in the lower end of the average ranges, while the children thirteen and fourteen years of age had mean IQ's just below 80, or at the division line between the classification of dull and feeble-minded.

Interestingly enough, when infants were removed from the same types of homes and placed in adoptive homes before they were six months of age, they showed a quite different pattern of growth. Instead of being in the low average ranges in early childhood, they were superior. This result was another surprise When Doctor Skeels began his work as state psychologist for the orphanage, he had been horrified at the policy of the superintendent in placement of children in foster homes. Without any regard to social histories of insanity, low mentality, incarceration for criminal offenses, incestuousness and other undesirable elements in the immediate family background of many of the children, the superintendent had been placing children in good foster homes for adoption. The one restriction he observed was in terms of medical or physiological defect. Otherwise out they went.

With the intent of future protection of foster parents and children, Doctor Skeels got through a policy regulation that every child before final adoption papers were signed should have a complete psychological examination. He and his field workers then went out to foster homes scattered over the state to examine at the preschool ages children who had been placed in these homes in very early infancy. The workers went with the expectation of finding many children of low intelligence. In fact, they were prepared to discuss the problem with the foster parents and in some instances to recommend reconsideration of

adoption on the basis of probable future mental outlook for the child. Child after child, however, tested average or superior in intelligence, and the examiners went away without saying their piece. When the number of cases had mounted to fifty, and not a dull child in the lot, it became apparent that this was no chance phenomenon, but that there must be some good reason why these children with such poor true family social histories were superior in intelligence. The mean IQ of the first fifty children examined was around 115, or classified as superior. (That, by the way, is approximately the same as the mean IQ of children whose fathers are in the professional occupations.) Consequently there was instituted a series of research investigations delving more intensively into the problem. To date, some three to four hundred children have been examined, but the mean IQ remains at about the same figure. Some of the children have been followed through to six to eight years of age. They still classify as superior in mental ability.

One of the more colorful and spectacular findings was concerned with the intelligence of a small portion of the group whose true mothers were definitely known to be feeble-minded by actual test and by other evidence. Doctor Skodak studied sixteen such children placed in foster homes in early infancy. Their intelligence, too, at the preschool ages was superior. They were indistinguishable from the other children in the foster home group. This finding, incidentally, has been verified by an independent worker in another community. Mr. George Speer, psychologist with a child placement agency in Springfield, Illinois, had read Skodak's account and was disturbed by it. He gathered together the records of his agency for children whose true mothers were known to be feeble-minded, beginning the analysis with the intention of showing that Doctor Skodak was wrong, but ending by complete verification of her conclusions. He studied a group of about fifty children who had been removed from their own homes at various ages. The mean IQ of the mothers was around 50. When the children were removed at an early age and placed in boarding or adoptive homes they were normal in intelligence. The older they were at time of removal, the lower the IQ, until the children at twelve to fourteen years of age who had lived at home all their lives had a mean IQ of around 50, or closely resembling the mean IQ of the mothers. It appeared from this study that the length of time the children were under the care of their feeble-minded mothers was a direct factor in determining whether the children themselves would be feeble-minded.

I might mention in this connection that studies of children in isolated mountain communities indicate that the same phenomenon is at work there. I have been able to locate in the literature several independent studies, the results of which, taken together, are impressive. In each study, there was a marked decrease in IQ with age. Younger children of mountaineers (age six and seven years) were average or dull-normal, while older mountaineer children (fourteen to sixteen years) were feeble-minded. The steepness of the drop appeared to depend on the degree of isolation of the community.

Let me cite one more Iowa experiment that turned out unexpected results. As state psychologist, Doctor Skeels recently had occasion to transfer from the orphanage to an institution for the feeble-minded two children, who at about a

year and a half of age tested 35 and 45 IQ, and who showed marked developmental retardation in other respects. They presented rather typical pictures of mental deficiency. At the time of transfer there was no question in the minds of anyone that they were permanently committed to the institution for the feeble-minded. Imagine Doctor Skeels' surprise then, in making the rounds some months later, to discover that these children had literally been transformed. Among other things, they now tested near average in intelligence. Examination into the environment and experiences of the children revealed that they had been placed on wards with feeble-minded women of the higher mental ages where they were the only children, that they had been showered with loving attention, that the feeble-minded women had taken great interest in their language and motor development, and that there was an abundance of toys and play materials. In short, they were having about the same experiences as most children who live in their own homes. At this point, Doctor Skeels decided that what worked for two children, might work for others. Hence, other children were temporarily transplanted on an experimental basis. In all, thirteen such children with a mean IQ of 64 at the age of nineteen months were transferred. The environment proved to be a good one for them, too. In a year and a half they made a mean gain of 27.5 IQ points. At three years of age they had a mean IQ within the average ranges.

At this point you may be asking, "Why were you surprised at your results? Why did you expect them to be otherwise?" My answer to that is that they were contrary to what we had been taught and contrary to what is still being taught in many quarters. It is probably significant that none of these studies was begun with the preconceived idea that current teachings were wrong. Rather, time after time, we stumbled onto results that required reorganization of our thinking. Belatedly we are inquiring into the origin of the idea that intelligence is almost entirely innate, fixed within a very narrow range by hereditary limitations, and thus changeable only to a slight degree. We are inquiring also into the experimental evidence back of these ideas. It has become evident that the concepts of fixity did not originate with Binet, who devised the first intelligence test. On the contrary, the Iowa findings are clearly in line with Binet's theory as set forth in a brief chapter tucked away in the middle of a volume published in French. The title of this chapter is "The Education of Intelligence." In it, Binet describes his own efforts at increasing intelligence by suitable educational and training techniques. For some reason this highly illuminating discussion has been for a long time overlooked.

Some of you may be asking as others are doing, "Why were the Iowa investigators always the ones to meet with these continued and consistent surprises? Is Iowa the only place where such results are obtained?" At the beginning of this talk I said that the Iowa findings are not unique nor extraordinary. There is in the psychological literature a great deal of supporting evidence from independent investigators, but it is for the most part scattered and sometimes fragmentary.

There are some characteristics of the Iowa studies that do set them somewhat apart. The first is our interest in consecutive, repeated, long-time measures on the same individuals. A point that has often been overlooked is that time

takes its toll. An environmental condition that in a short time produces a small change, may in a long period produce a big change, provided, of course, that the change is cumulative and consistently in the same direction. Small changes in short periods have oftentimes been chalked up to errors of measurement, when in reality they may very well be segments in a long chain.

The second characteristic of the Iowa studies is that more extreme changes in conditions have been made than are customarily the case. In this respect we have been plainly fortunate from the research standpoint. It was a fortunate coincidence that our preschools and University schools were the types to produce increases in intelligence. It was fortunate, too, that the orphanage superintendent followed his own unique policy of placement of children in foster homes, without any regard to the teaching of best social service practice. Probably nowhere in the country can that condition be duplicated. Probably, too, few investigators will have an opportunity to study two groups of children under as controlled and divergent conditions as those in the orphanage preschool project.

To those who have not followed our investigations through their successive stages, some of our recent maneuvers appear, to say the least, extreme. Indeed, it does sound a bit peculiar to approach a political body such as the Iowa Board of Control with the request for permission to place a group of young children in an institution for the feeble-minded in order to make them normal. We cannot blame too greatly the magazine *Time* for carrying an account of this investigation under the title "Feeble-minded Love."

A persistent question that I am asked is "Have you really measured intelligence?" To some, the idea that we must get constancy of IQ is so firmly ingrained in their concept of intelligence, that they necessarily conclude that the test is no good when constancy is not obtained. One reply to this question is, of course, that we have used precisely the same test that has been used by those who do not get changes. Our results serve to emphasize the fact that intelligence is functional and that it must be measured in terms of performance. I know of no preeedent that leads us to expect that any behavior or function of the organism should remain at a constant level regardless of environmental demands, experiences, exercise or training.

We have need, it is true, for improvement of our measuring instruments. We need more reliable and valid intelligence tests. We need better control over experimental conditions. When dealing with living human beings it is often difficult to set up as complete control over environmental conditions as we would like from the standpoint of research. On the other hand, fortunately, the welfare of children and the needs of research often go hand in hand. Perhaps it is because we are affiliated with an organization that has both words in its title, the Iowa Child Welfare Research Station, that we are so strongly conscious of the implications of findings for the welfare of children. Perhaps it is because of the fact that, while our right hand is carrying on research, our left hand is trying to interpret and translate the findings into the betterment of the welfare of children. At any rate, we feel that the tenor of our results on intelligence are in line with social betterment and we take some comfort in that thought.

SULFANILAMIDE AND RELATED CHEMICALS IN THE TREATMENT OF INFECTIOUS DISEASES*†

WESLEY W. SPINK, M.D.

Last fall the University of Minnesota Medical School celebrated its fiftieth anniversary. A scientific program was arranged and included addresses by outstanding scientists of this country and Canada. The committee in charge of the program wisely selected a central theme for all the addresses and round-table discussions. That theme was "Some Trends in Medical Progress with Particular Reference to Chemistry in Medicine." All of the speakers emphasized the tremendous contributions that chemistry has made to all branches of medical pursuit. Tonight it is my purpose to discuss with you one of the most significant advances made in the treatment of human disease. This momentous discovery which has already alleviated untold suffering is a further tribute to the ingenuity of the chemist.

Before unravelling the story of sulfanilamide, it is necessary to review briefly the development of our knowledge concerning infectious diseases. Professor Hans Zinsser has defined an infectious disease as follows: "When microörganisms gain entrance to the animal or human body and give rise to disease, the process is spoken of as an infection." It was a little more than fifty years ago when this relationship between disease and bacteria was definitely established. It is true that during the fifteenth and sixteenth centuries when syphilis was so common, it was suspected by some that an infectious agent was responsible. But it remained for those intellectual giants of the latter part of the last century to prove that bacteria caused disease. Leaders among these were the French chemist, Louis Pasteur, and the Prussian general practitioner, Robert Koch.

When the causes of infectious diseases became known, efforts were made to control them. One of the methods established was to prevent the organisms from reaching human tissue. Excellent examples of this preventive type of medicine were the control of malaria, yellow fever, cholera, and typhoid fever. Another method was to prepare the human tissue so that if the bacteria did strike they were defeated from the start. This included vaccinating against smallpox and typhoid fever, and immunizing against diphtheria. Still another means of combatting infectious diseases was made available. If the bacteria had already invaded human tissue and caused disease, through the elaboration of toxins, serum such as antitoxin could be used to shorten the illness. Illustrative of this was the introduction of diphtheria antitoxin into the therapy of diphtheria.

There are many interesting chapters in the annals of medical history concerning attempts to control and combat infectious diseases with chemical com-

* From the Division of Internal Medicine of the University of Minnesota Hospital and Medical School.

† One of the thirteenth annual series of public lectures sponsored by the Minnesota Chapter of the Society of the Sigma Xi.

pounds. Consider the epoch-making contribution of Joseph Lister who introduced carbolic acid into the operating room to prevent the contamination of operative wounds by bacteria. For years, it had been common knowledge that certain chemicals would kill microörganisms in large numbers, and do so in a short period of time. Why not then inject these chemical solutions into human beings whose bodies were being ravaged by bacteria? The major difficulty with this procedure has been that these chemicals not only killed the bacteria but destroyed the human celsl as well. A definite advancement was made when Paul Erlich and his chemists synthesized an arsenical compound which could be injected into the blood with reasonable safety for the treatment of syphilis. But this was not an accomplishment completed without many disappointments. Although they knew that arsenic spelled death for the spirochete of syphilis, they also knew that this element was very toxic for human tissues. The problem that confronted them was to introduce arsenic in such a chemical combination that it would still be effective against the spirochete and yet not be injurious to the host. After experimenting with many combinations—606 to be exact—they gave arsphenamine to the world. Since then other chemicals have been safely introduced into the human organism for the treatment of infections, such as emetine hydrochloride for amoebic dysentery, and atabrine for malaria.

In discussing the history of sulfanilamide, Schulte has stated, "Sulfanilamide did not appear suddenly, but was the product of numerous investigations which extended over a period of thirty years." Like so many other major scientific discoveries, the successful introduction of sulfanilamide into the treatment of human disease was a summation of the ceaseless work of many individuals. I should like to cite for you a few of the persons whose names are closely linked with one of the most outstanding therapeutic triumphs of our time. Time does not permit us to include everyone.

P. Gelmo, a chemist working with the interest of the German dye industry in mind, was apparently the first one to synthesize para amino benzene sulfonamide. He reported his investigations in 1908. Little did he realize that a quarter of a century later this compound would be known as sulfanilamide, and used in the treatment of human infections.

M. Heidelberger and W. A. Jacobs, two Americans working in the Rockefeller Institute in New York, observed in 1919 that certain azodyes, including para amino benzene sulfonamide hydrocupreine, would kill bacteria in the test tube. They stated in their paper at the time that their colleague, the late Dr. Martha Wollstein, would extend these observations, but she never did.

F. Mietzsch and J. Klaren, two German chemists working in the I. G. Dye Works in Elberfeld synthesized a red dye called Prontosil, and patented it on December 25, 1932. G. Domagk, the young director of the Institute of Experimental Pathology in the same dye works, observed in 1932 that Prontosil protected mice against fatal doses of hemolytic streptococci. He announced the results of his important investigation in 1935, and at the same time, stated that a closely related chemical compound, Prontosil-Soluble, had similar protective properties.

At this stage certain workers in France became interested in the progress that the Germans had made. Important contributions were made by Levaditi

Vaisman, Fourneau, and Girard. J. Trefouël, Mme J. Trefouël, F. Nitti, and D. Bovet made a most significant announcement late in 1935 to the effect that the action of Prontosil on microörganisms was due to its being broken down in the body to form sulfanilamide, and that the latter compound was as efficient a therapeutic agent as Prontosil. Their conclusions were based in part upon the observations of Heidelberger and Jacobs.

L. Colebrook and M. Kenny, working in England, demonstrated, in 1936, the value of Prontosil and Prontosil-Soluble in the treatment of puerperal infections.

P. Long, E. Bliss, and E. K. Marshall, Jr., and their associates at Johns Hopkins University, in 1936, confirmed the clinical and experimental findings of the European investigators. This Baltimore group is largely responsible for placing this new form of chemotherapy upon a firm foundation in this country.

The successful clinical application of Prontosil on the therapy of the dreaded streptococcal infections is one of the most spectacular medical triumphs of our generation. Before we knew about Prontosil, there was no known specific agent that was of much value in the treatment of this type of infection. Consequently, the mortality rate was high. It should be pointed out that whereas Prontosil had been extensively used in England and on the continent, it was never introduced for general use in this country. Sulfanilamide has been the drug of choice in the treatment of the various diseases due to the hemolytic streptococcus. In evaluating the results of sulfanilamide therapy in this type of infection, it has been observed that the drug has shortened the duration of the disease, prevented complications, and reduced the mortality rate. Following are some of the streptococcal infections for which sulfanilamide has been of value: puerperal fever, erysipelas and cellulitis, septicemia, scarlet fever, acute otitis media, mastoiditis, meningitis, pneumonia, tonsillitis, and peritonitis.

Puerperal fever is an invasion of the tissues by streptococci occurring in mothers at the time of childbirth or shortly thereafter. It is a disease that has been viewed with alarm for many years by the medical profession because it has such a high death rate; it is contagious, often sweeping through a maternity hospital; and specific therapy has been wanting. The investigations of Colebrook in England, and others, have shown that sulfanilamide and its related compounds have lowered the death rate, shortened the duration of the disease, and prevented disabling complications.

Erysipelas and cellulitis, which are streptococcal infections of the skin and their deeper structures, have responded well to sulfanilamide therapy, provided the drug is given early in the course of the disease. These infections often kill patients because the streptococci invade the blood stream. Sulfanilamide not only affects the local lesion, but keeps the blood free of organisms.

Septicemia, or the state wherein streptococci actually reproduce in the circulating blood, has been one of the most feared of all infections. The onset is sometimes insidious, but terminates in a fulminating and often fatal infection. You probably all know of examples where an individual had an innocent appearing lesion, such as blister which had ruptured, and then streptococci invaded the injured tissue, quickly entered the blood stream, and death resulted. Treatment in most instances has been ineffective. The mortality rate was

over 75 percent. Sulfanilamide therapy has cut this rate at least in half, and we may expect even better results in the future.

Scarlet fever, for the most part today, is a mild streptococcal infection, but it may result in serious complications. Convalescent human serum or potent antitoxin obtained from the serum of immunized horses are useful and often adequate in the treatment of scarlet fever. It would appear that the early administration of sulfanilamide may prevent the formation of metastatic bacterial complications. In other words, antitoxin neutralizes the toxin elaborated by the streptococcus, whereas, sulfanilamide acts directly upon the organism. Doctors Sako, Dwan, and Platou, working at the Minneapolis General Hospital, were among the first in this country to show the value of sulfanilamide in the treatment of scarlet fever.

Acute otitis media, an infection of the middle ear which is so common in children, is a dangerous disease. It may cause permanent loss of hearing, mastoid disease, or it may extend to the meninges and brain resulting in a fatal outcome. Sulfanilamide, judiciously administered under the watchful eye of the physician, may often interrupt the progress of the infection and terminate the disease permanently.

Streptococcal meningitis is the most serious of all infectious caused by this biological agent. Recovery from this disease was an uncommon occurrence before the present era of chemotherapy. The use of sulfanilamide has been followed by startling results. The mortality rate has been reduced from 98 percent to around 20 percent.

While the results are less dramatic in patients with streptococcal pneumonia and empyema, sulfanilamide is of benefit. Mention should be made of the treatment of acute tonsillitis, and pharyngitis due to the streptococcus. This includes the so-called "septic sore throat." Sulfanilamide is of value in those cases where the condition is definitely due to the hemolytic streptococcus. But I would like to emphasize the dangers inherent in administering the drug to every patient who has a sore throat. As shall be pointed out, sulfanilamide and its related compounds often cause severe toxic conditions which may be of more serious consequence than the disease for which it is given.

Although sulfanilamide and its related compounds were introduced primarily for the treatment of streptococcal infections, it was soon observed that other types of infections were favorably affected by their use. Among these other diseases was gonorrhea. It has been estimated that this infection afflicts around a millon people a year in this country. It has caused untold suffering and chronic illness in its victims, some of them having acquired the disease through no fault of their own. Treatment has been very unsatisfactory. Because of the social stigma attached to the disease, these patients often ferreted out quacks and pseudo-physicians in an attempt to obtain a cure. One of the good fortunes of this age was the announcement coming from Johns Hopkins University that sulfanilamide would cure gonorrhea. It is now accepted that this compound is a specific therapeutic agent for gonorrhea. One of its outstanding contributions is that the devastating complications that gonorrhea causes, such as crippling arthritis and blindness, are prevented. On the other hand the drug may have caused a social menace in that infected individuals often take

the drug without the advice or jurisdiction of a physician. Lacking laboratory confirmation of a cure, they often have a latent form of the disease, and are capable of transmitting it to others.

Another serious infectious disease in which sulfanilamide has provoked almost miraculous cures is meningococcal meningitis. Curiously enough, the causative agent, which is the meningococcus, has biological characteristics that are closely related to the gonococcus. It has appeared only logical then to try the drug in the treatment of meningococcal meningitis, and it worked. I have seen a child in deep coma afflicted with the disease, to whom sulfanilamide was administered, and within seventy-two hours an almost unbelievable transformation in physical well-being occurred. At the end of that time, he was sitting up in bed playing with his toys. Even though we have potent immune serum for the treatment of this disease, sulfanilamide appears to offer the best form of therapy. Whether serum should be used along with sulfanilamide is still an open question.

There are several other diseases that are either cured or favorably influenced by sulfanilamide therapy. Trachoma, which is a painful, chronic infection of the eye often resulting in blindness, has yielded in some instances sulfanilamide. Many infections of the urinary tract, such as cystitis, and pyelonephritis are permanently cured by this drug. Sulfanilamide is apparently of some merit in the treatment of undulant fever, a disease transmitted to man either directly or indirectly from cattle and hogs. However, we have encountered disappointing results in several patients with undulant fever treated at the University Hospital.

While we can continue to extol the virtues of sulfanilamide, and enumerate other infectious diseases where limited data show that sulfanilamide is a helpful remedy, time does not permit. It should be pointed out that there remains a group of infectious diseases where sulfanilamide is of very doubtful value, and its use in some of these may be actually harmful. They include typhoid fever, paratyphoid fever, staphylococcus infections such as osteomyelitis, carbuncles and boils, acute rheumatic fever, the common cold, epidemic influenza, Rocky Mountain spotted fever, rheumatoid arthritis, and tuberculosis.

It is of interest that the drug has been used as a prophylactic; that is, to prevent disease. I shall mention only two examples. Knowing that children who have had acute rheumatic fever are quite likely to have a recurrence when they contract streptococcal infections, certain well-known physicians have given the drug in small doses to these children to prevent streptococcal sore throats. The results are very promising, but demand further investigation to see if the prolonged administration of the drug to growing children has any harmful effects. Another prophylactic use of sulfanilamide was worked out by the surgeons at the Minneapolis General Hospital. It had been recognized for years that when an individual had a compound fracture with fragments of bone protruding through the skin, and the wound contaminated by dirt and microörganisms, there was a great danger of infections occurring in the injured tissues. To prevent these infections, these surgeons have placed pure sulfanilamide crystals into the wounds with the results that the incidence of infections following compound fractures has been considerably reduced.

The question is often raised, how does sulfanilamide work? The answer is still shrouded in some mystery, but we can say that the drug acts directly upon the microörganisms interfering with their metabolism. They fail to reproduce as rapidly, and those remaining are injured so that the defense mechanism of the body can cope with and kill them. As a matter of fact, there is some evidence that sulfanilamide may actually kill small numbers of organisms.

Thus far, we have extolled the virtues of sulfanilamide. It must be emphasized again and again that sulfanilamide and its related compounds are potentially dangerous drugs. Their administration to patients may result in serious toxic reactions. Under no circumstances should any individual take any of these drugs unless they are prescribed by a physician. The physician, in turn, must be prepared to observe the patient closely, and withdraw the drug when toxic signs and symptoms manifest themselves. Shortly after sulfanilamide had been accepted by the medical profession of this country, a number of human lives were sacrificed following the ingestion of a preparation known as Elixir of Sulfanilamide. It was discovered that the cause of these deaths was not due to sulfanilamide, but to a constituent of the Elixir, diethylene glycol. In order to prohibit the hasty marketing of new drugs with a repetition of another tragedy, Congress revised the Federal Food and Drug Act. At the present time, new chemotherapeutic agents are made available for the medical profession only after they have been thoroughly investigated as to their toxic properties and therapeutic value.

I would like to discuss now the toxic reactions that are caused by sulfanilamide in the human. It is well that the patient, the relatives, and physician should have some knowledge of these manifestations. Some of these are more serious than others. Certain of these may cause the patient and those caring for him some alarm, but may not be a contraindication to a continuation of therapy. The first group of toxic manifestations are related to the central nervous system. They are dizziness, headache, mental depression, giddiness, nausea and vomiting, convulsions, and psychoses. Usually, we do not consider the first four serious enough to warrant withdrawal of the drug when the patient is kept in bed. However, the exhibition of dizziness and giddiness may be of serious moment in ambulatory patients who endeavor to carry on their daily work, particularly in those individuals operating motor vehicles, or engaged in dangerous occupations. Bed-ridden patients may become so disoriented and maniacal, that cessation of drug theray may be necessary. Nausea and vomiting are usually not severe enough to necessitate suspension of sulfanilamide treatment.

A majority of the patients taking sulfanilamide develop varying degrees of cyanosis of the skin and mucous membranes. This bluish discoloration is due to the conversion of a part of the hemoglobin into methemoglobin, and rarely sulfhemoglobin. Although the morbid appearance of the patient may startle the uninitiated, we do not consider methemoglobinemia, a contraindication for further administration of the drug.

A more serious toxic reaction is so-called drug fever. It usually occurs after an individual has taken sulfanilamide for several days. While the patient is receiving sulfanilamide, the temperature may approach normal, and then begin to rise again, sometimes quite high. The problem then confronting the physi-

cian is whether this secondary rise in temperature is due to a spread of the infection or due to drug sensitivity. Obviously, the treatment is quite different for each condition. When the fever is due to sulfanilamide, its administration should be discontinued at once. The appearance of drug fever may herald the onset of more serious toxic reactions if therapy is continued. When the drug is omitted, the temperature again approaches normal. We have been impressed by the clinical observation that once a patient has had drug fever, it is likely to occur again when only a single dose of sulfanilamide is given at a future time. This toxic reaction emphasizes again the inherent danger of self-medication without the attendance of a physician. It also serves to express an opinion shared by physicians in general that sulfanilamide should only be given to those patients having an infection that threatens their lives, or is likely to produce serious complications. If the drug is taken indiscriminately by individuals, and drug sensitivity results, it may be impossible to give sulfanilamide in the future when it is definitely indicated as a life-saving measure.

Various types of skin eruptions occur as a result of sulfanilamide. These eruptions often appear along with drug fever. The skin lesions may simulate those occurring in measles and scarlet fever. Intense itching of the skin may be present. There may be hemorrhages into the skin. Angioneurotic edema has been described. With the first appearance of the eruption, no further sulfanilamide should be given. Skin lesions may present themselves at a subsequent time when only one dose of the drug is given.

A more subtle toxic manifestation of sulfanilamide is liver dysfunction. This may or may not be accompanied by jaundice. In a few reported instances, the damage to this vital organ has been so severe that the patients died. Whether the temporary liver dysfunction that the majority of patients have while taking sulfanilamide results in any permanent damage will depend upon further investigation.

One of the most common signs of sulfanilamide toxicity is anemia, or the destruction of red blood-cells in the circulating blood. This usually happens after the drug has been taken for several days. In the majority of cases, this destruction of cells is only of moderate severity, but not infrequently there may be a sudden and precipitous drop in the level of hemoglobin, endangering life if drug therapy is not discontinued. This acute destruction of red blood-cells is apparently another expression of drug sensitivity, since the patients who have exhibited this phenomenon may have the same reaction when an initial dose of the drug is given several months after the first reaction.

A more serious form of blood dyscrasia resulting from sulfanilamide is a disturbance in the formation of the white blood-cells. In common with other toxic signs, this decrease in the number of circulating leukocytes emerges after patients have ingested the drug for several days. When the level of white blood-cells does drop below normal, sulfanilamide therapy should be suspended at once. One of the most feared of all compilations in this respect is agranulocystosis, wherein there is a failure of the bone marrow to deliver leukocytes to the circulating blood. This condition is highly fatal.

Other toxic expressions of sulfanilamide have been encountered, but they are less common. Among these is neuritis. Optic neuritis with blindness has been

recorded, as well as neuritis of the peripheral nerves. I have dwelt at length on the toxicity of sulfanilamide for the human organism in order to emphasize the inherent danger in the injudicious use of the compound. I believe that you will agree with me when I state again that self-medication is to be deprecated.

As was anticipated, new derivatives of sulfanilamide have been synthesized and used in the therapy of certain infectious diseases. In May, 1938, Dr. L. E. H. Whitby of London announced that a new derivative known as sulfapyridine was more effective than sulfanilamide in the treatment of infections due to the pneumococcus. The most prevalent type of infection caused by this organism is pneumonia. It is also the etiological agent of a severe and fatal form of meningitis. Although statistics for pneumococcal pneumonia have shown a reduction in the mortality rate following the widespread use of immune serum, there is still considerable room for improvement. Sulfapyridine has proven to be an effective therapeutic agent for this type of pneumonia. It is relatively easy to administer, and is less costly than serum. This does not mean that the use of serum has been abandoned. There is some evidence that in the more severe cases of pneumonia, the combined employment of immune serum and sulfapyridine is more efficient than either one alone. Furthermore, there are some individuals who cannot tolerate sulfapyridine because of its toxicity. Treatment of pneumococcal meningitis with sulfapyridine has been productive of most encouraging results.

Sulfapyridine has also been successfully applied to the therapy of staphylococcal infections. Treatment of this type of infections with sulfanilamide was largely ineffective. Sulfapyridine has also been useful in the treatment of gonorrhea. Patients whose infections are resistant to sulfanilamide therapy may be cured with sulfapyridine

Sulfapyridine precipitates toxic signs and symptoms that make it a disagreeable drug to prescribe at times. The compound is more soluble than sulfanilamide and, therefore, is absorbed eratically from the intestinal tract. This factor of absorption is important because successful therapy depends upon an adequate amount of the drug in the blood and tissues. Sulfapyridine also causes severe nausea and vomiting in many patients, so that it may be impossible to continue giving it. Another toxic manifestation not shared by sulfanilamide is that acetylated sulfapyridine crystals may be precipitated along the genito-urinary tract causing serious kidney dysfunction and pain. In addition, sulfapyridine results in other toxic signs that have been described for sulfanilamide.

What of the future of chemotherapy? Hundreds of new chemical compounds have been synthesized, and are being investigated in many laboratories. It is not unlikely that drugs less toxic for the human organism, and just as deleterious, if not more so for bacteria, will be available in the future. At the present time, we are investigating a new preparation at the University Hospital called sulfathiazole. In conclusion, I have endeavored to present to you a general review of this new form of chemotherapy. It is a rapidly developing field and, perhaps in the near future, much of what I have said will be only medical history.

TWO GENTLEMEN OF UNION*

W. H. Cowley

President of Hamilton College

Founders' days are annual tributes to the social mindedness and foresight of the men of the past who have made possible the present. But for the devotion of a group of Schenectady men Union would not have come to life 145 years ago, and instead of our meeting here today we should be scattered in all the states of the Union and perhaps in all the states of the world. That would be unfortunate for us and, as I shall try to show, a severe misfortune for the entire enterprise of American higher education.

I have just said that had Union not been established it would have been "a severe misfortune for the entire enterprise of American higher education." This may seem to be an overstatement, but I am sure that it is true, and in this paper I should like to review why it is true. Social institutions are not only founded, but if they are to meet the needs of newer eras and new generations, they must again and again be refounded. If refounders appear, an institution keeps abreast of the times and moves forward. If refounders do not appear, an institution decays and eventually dies.

Union has been refounded several times, as has Hamilton; but I shall not today speak about Union itself but rather about two eminent sons of Union, two men whose contributions to the development of American higher education were so important that they will always be counted among the great educators of the nineteenth century. They are Francis Wayland of the class of 1813, later president of Brown University, and Henry P. Tappan of the class of 1825, later president of the University of Michigan. These men were no ordinary college presidents. They were vigorous torch bearers in the advance guard of higher education. Few were and are their equals, and Union can always be proud to have produced them. They are large, luminous, and permanent diamonds in your tiara.

They were great men because they saw that new social forces were accumulating strength and that the colleges needed to reorganize to meet the demands of the new day which these forces were producing. Against tremendous opposition they set about to modernize higher education, and the reforms which they proposed established the pattern of change which all nineteenth century higher education followed. Sensitive men, they felt the pulse of their time, and they set about the huge task of synchronizing the college with American life.

Both of them saw that science was on the road to be the most powerful factor in the future of the nation and of the world, and both insisted that the colleges must break the stranglehold of the classical curriculum or dwindle to insignificance. In books, speeches, and articles in the journals of the day they pleaded for the cause of scientific education; and as the presidents of two important universities they maneuvered curricular and organizational changes

* Founders' Day address at Union College, 1940.

to provide for scientific instruction. In order to understand the difficulties which they faced, may I review briefly the antagonism to science which they met among their academic colleagues.

Medical scholars took no interest in nature . Aristotle, their intellectual model, had been a tireless classifier of a wide variety of natural phenomena, but so absorbed were they in attempting to harmonize revelation with reason by means of syllogistic logic that they had no time for the observation and study of the world in which they lived. Essentially they were otherworldly. The modern hymn, "I am but a stranger here, heaven is my home," aptly characterizes their motivation. St. Ambrose, writing about the year 389, similarly expressed the point of view which controlled scholarly thought for more than a millenium. Discussing the undesirability of astronomical observations he wrote: "To discuss the nature of the earth does not help us in our hope of the life to come. It is enough to know that Scripture states, 'That He hung up the earth upon nothing.' Why then argue whether He hung it up in air or upon the water . . . The majesty of God constrains it by the law of his Will."

This concept dominated all scholars until a number of Greek scientific treatises were recovered in the thirteenth century and a few choice spirits, such as Roger Bacon, were stimulated to make simple scientific experiments. Nothing of major scientific significance happened, however, until early during the sixteenth century when Copernicus developed the heretical helocentric theory and started astronomy on its modern road. Progress was slow, but during the seventeenth and eighteenth centuries a succession of scientific thinkers broke completely from the moorings of revelation. Francis Bacon wrote the "Novum Organum." The rationalists Descartes, Spinoza, and Leibnitz produced revolutionary works in mathematics and philosophy. The empiricists Locke, Berkeley, and Hume penned incisive discussions of social problems as well as of science and philosophy. Then in 1687 appeared Newton's "Principia" which irrevocably killed the geocentric theory of the universe—thus, as one writer has pointed out, "relieving God and his angels from hourly responsibility" for the movement of the planets. By the middle of the eighteenth century, because of the achievements of these men and their associates, the overture of modern science had been written, orchestrated, and played to a small but tremendously aroused audience.

Aside from a few stirrings in the German universities, higher education the world over ignored these stupendous developments in science. All the seats of learning were controlled by the church and by the classicists who had substituted literary for theological revelation. So unwelcome in the universities were the ideas and persons of the scientists that but a small handful of the great thinkers of the seventeenth, eighteenth, and early nineteenth centuries were professors. Newton had started his career at Cambridge, but he found the atmosphere there so ungenial that he resigned and took a position in the London mint.

In the New World the academicians followed the leadership of their European brethren and ignored science until the early nineteenth century when a few courses were established. The word *science* was regularly used in the catalogues of the colonial colleges, but it was used synonymously with *knowledge,*

the meaning of the Latin word *scientia*. As late as the eighteen fifties Andrew White, who later as president of Cornell became a strong supporter of scientific education, abhorred the sciences. In his autobiography he describes his attitude as a Yale undergraduate:

> One day in my senior year, looking toward [the newly established Sheffield Scientific School] I saw a student examining a colored liquid in a test-tube. A feeling of wonder came over me. What could it be about? Probably not a man of us in the whole senior class had any idea of a chemical laboratory save as a sort of small kitchen back of a lecture-desk . . . My wonder was succeeded by disgust that any human being should give his time to pursuits so futile.[1]

This was the attitude toward science which students learned from their professors. From their professors they also learned to scorn the educational implications of the industrial developments which were just beginning to become significant. For about a hundred years "men in the mines, the factories, the machine shops, and the clockmakers' shops" have been "manipulating materials and imagining new processes,"[2] and inventing new machines to do the work which all during the history of civilization had been done by hand. Early during the nineteenth century these gifted mechanics joined forces with the pure scientists, and the results they produced were and continued to be phenomenal. They were not only phenomenal in themselves but they also changed the nature of all civilized institutions, education—despite the protests of college faculties—prominently included.

Wayland and Tappan came to manhood during the years in which the pure and applied sciences were knocking on the doors of the colleges. Since they were both clergymen and philosophers and since they had both been educated in the old-time classical curriculum, they might have allied themselves with the conservatives and fought the inevitable. They were, however, too keen and too sensitive to the spirit of the time to misjudge the problem of their generation. Thus they pitched in and became leaders of the movement to give science a place in the college curriculum.

Wayland had been president of Brown for more than a decade before he awoke to the challenge of the situation, but in 1842 he wrote one of the most important books that had appeared in the two centuries of American higher education, and in 1850 he followed it with a brilliant report to his board of trustees. Both documents demanded that the colleges awake from their dogmatic slumbers and welcome rather than fight the new day. Here are his own words from his book published in 1842:

> The present system of collegiate education does not meet the wants of the public . . . Change after change has been suggested in the system without however any decided result . . . Although this kind of education [collegiate] is afforded at a lower price than any other, we cannot support our present institutions without giving a large portion of our education away.[3]

In his 1850 report to his board of trustees he used even stronger language. He put before them a study that he had made of college enrollments and demonstrated that enrollments were shrinking. He wrote:

> The number of those who are seeking a collegiate education is actually growing less, and this moreover at a time when the subject of education has attracted the attention of our whole community to a degree altogether unprecedented in our history (pp. 30-31). Our colleges are not filled because we do not furnish the education desired by the people . . . We have produced an article for which the demand is diminishing. We sell it at less than cost, and the deficiency is made up by charity. We give it away, and still the demand diminishes (p. 34). We must carefully survey the wants of the various classes of the community and adapt our courses of instruction, not for the benefit of one class [the professional class], but for the benefit of all classes (pp. 50-51). We have in this country, one hundred and twenty colleges, forty-two theological seminaries, and forty-seven law schools, and we have not a single institution designed to furnish the agriculturist, the manufacturer, the mechanic, or the merchant with the education that will prepare him for the profession to which his life is to be devoted (pp. 56-57). The time would seem to have arrived when our institutions of learning are called upon to place themselves in harmony with the advanced and rapidly advancing condition of society (pp. 58-59).[4]

Obviously Wayland wielded a powerful pen and used it to advantage in demanding a necessary reform in higher education. All the measures which he proposed did not turn out to be sound. That is not important. What is important is that he read his times aright and urged that something be done to harmonize education with the life of the nation. Today we think of Eliot, White, and Gilman as the great leaders of nineteenth century education, but Wayland antedated and prepared the way for them. They stood on his shoulders, and in no small measure they were giants because he was a giant.

And so was Tappan. He, too, prepared the way for the leading educators of a generation later. He was not a success, however, as president of the University of Michigan. After a decade of heart-rending effort, he resigned and departed for Europe, a broken-hearted man who was never to return to his native country. Before he died, however, he saw from afar the fruition of his efforts not only at Michigan but all through the nation.

Tappan failed because he entered upon his presidency with a formula, and the formula did not work because the times were not ripe. His formula was this: the establishment of the Prussian system of education at the University of Michigan. In his inaugural address he declared: "Michigan has the credit of proclaiming the Prussian model. She has wisely adopted the most perfect standard as her standard."[5] In a book he published two years previously he wrote to the same effect and said of the Prussian system that "we cannot well be extravagant in its praises . . . It furnishes every department of life with educated men and keeps up . . . a supply of erudite and elegant scholars and authors for the benefit and glory of their country and the good of mankind."[6]

Tappan lauded and sought to emulate the German system of education because German universities and technical schools had for decades been consciously striving to support the work of the pure scientists on the one hand and the industrial needs of the nation on the other. With Wayland he wholeheartedly believed in the insistent necessity of "an attempt to meet the demands of the age."[7] All his thinking stemmed from that objective. His studies of German education led him to believe that American education should follow the German model. He did his best to put his belief into practice. He failed, but twenty years later other men—modifying his formula somewhat—succeeded because they were able to learn from his pioneering efforts. To him went the bruises and the scars of the trail-blazer; to others went the plaudits of success.

* * * * *

Almost a century has passed since Wayland and Tappan finished their work. We have learned much since they passed from the scene. We have learned, for example, that scientific and utilitarian education have contributed tremendously to American life but that they have created as many educational problems as they have solved. We have learned that the German system of education stood on feet of clay. More important than anything else, we have learned that the solutions found for the problems of one generation will not satisfy the next generation.

These two gentlemen of Union were keener than most of their contemporaries in seeing and understanding the problems of their times. Their contributions to the on-moving of higher education were immense. The greatest of all was their insistence that colleges and universities should "meet the demands of the age." The demands of our age are infinitely more complex and enormously more exacting than those with which Wayland and Tappan struggled. On this day of genuflection to the past, we pray that Union may in the twentieth century produce educational leaders comparable in intelligence, breadth of vision, and social-mindedness to her two great sons of the nineteenth, Francis Wayland and Henry P. Tappan.

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[2] Mumford, "Technics and Civilization" (1934), pp. 215-16.

[3] Wayland, Francis, "Thoughts on the Present Collegiate System in the U. S.," Boston: Gould, Kendall & Lincoln, 1842, pp. 16-17.

[4] "Report to the Corporation of Brown University," March 28, 1850, Providence: George H. Whitney.

[5] "A Discourse Delivered by Henry P. Tappan," Detroit, 1852, p. 5.

[6] "University Education," New York: George P. Putnam, 1850, p. 45.

[7] *Ibid.*, p. 80.

THE PROBLEM OF POLIOMYELITIS*

J. C. McKinley

Poliomyelitis is known under the terms acute poliomyelitis, acute anterior poliomyelitis, infantile paralysis, and Heine-Medin's disease.

The condition may be defined roughly as an acute contagious disease which affects mainly the central nervous system and often produces distressing residuals of muscular paralysis of varying severity. It is caused by a virus and occurs strikingly in epidemics. These points will be elaborated in the course of the subsequent remarks.

THE CLINICAL SYNDROME

The first description of the clinical picture of poliomyelitis is generally traced to a book on the diseases of children written in 1784 by a prominent English physician by the name of Underwood. The description is very brief and suitable speculation exists as to whether it actually refers to poliomyelitis. In the fourth edition of his book in 1799 he gave a much more acceptable description of the condition, but still showed a great lack of appreciation of what we now understand to be the diagnostic features. Certain references are found in ancient records and statuary that suggests the occurrence of poliomyelitis in ancient times, but other possible explanations of the abnormalities portrayed are just as logical.

Just a hundred years ago (1940) Jacob von Heine of Connstaat, Germany, published a monograph on paralytic conditions of the lower extremities and their treatment. His descriptions clearly referred to poliomyelitis, but were limited mainly to the type in which only the lower extremities were involved. Our knowledge of the disease in terms of modern understanding may be said to begin with Heine's monograph.

The next real advance came in 1887 when Medin observed an outbreak of forty-four cases in Stockholm. Previous to that time the disease had usually occurred in sporadic form, but Medin now recognized the epidemic nature of the condition and saw a sufficiently large number of cases so that he could construct a really adequate description of the several clinical types.

Because of the contributions of Heine and Medin to our knowledge of poliomyelitis, the condition is often spoken of as the Heine-Medin disease.

The symptoms in the acute stage usually become pronounced within a matter of hours. Commonly the patient acts and feels as though he had a simple head cold; a running nose, a sore throat, and a general feeling of tiredness and achiness are the usual beginning symptoms. This period may last a day or two before further symptoms occur, or new symptoms may appear very rapidly. Headache of severe and persistent type and stiffness of the back and of the neck, especially on bending forward, become prominent. The patient generally

* One of the thirteenth annual series of public lectures sponsored by the Minnesota Chapter of the Society of the Sigma Xi.

has a low-grade fever, up to 101° or 102° Fahrenheit. Then within a period of from a few hours to a few days, weakness in one or another of the voluntary muscle groups may appear in light or severe form. The lower extremities are most commonly involved though any groups of muscles in any combination may become weak. The weakness may stop at this point, or it may progress to absolute paralysis in certain of the muscle groups with weakness in the others or to extremely severe paralysis of nearly all of the voluntary muscles of the body. In these more severe cases it is common to have a paralysis of the muscles which move the chest wall and of the muscles of the diaphragm so that the patient develops inability to breathe. This is the most common cause of death in poliomyelitis. The paralyzed muscles become extremely tender to direct pressure, or to stretch from movements of the joints. In the vast majority of cases the temperature disappears within a week or ten days, the extension of the paralysis stops, and the patient enters upon the stage of convalescence. Usually the tenderness of the muscles remains for an additional period of three to six weeks, however, and the stiffness of the neck and back for two or three weeks. In those muscle groups that are less severely paralyzed the return of strength is rather rapid and usually complete within two or three months. On the other hand, in the muscles that were severely paralyzed from the first, there is usually little tendency for any marked return of function during this first two or three months after the acute infectious period of the disease. Under good orthopedic care the maximum improvement is reached within one or two years and very little more can be expected in the way of improving the paralyzed or weakened muscles after that time. In those cases which have not been given continuing orthopedic care after the acute stage of the disease some improvement is possible even after several years have elapsed by appropriate support and exercises. Special operative procedures are used by the orthopedist by means of which functioning muscles are substituted for those that have become permanently paralyzed. Surgical correction of deformed joints is also an important part of the late treatment. This could be the subject of a complete lecture on poliomyelitis, but really does not come within the present considerations.

During the period of acute infection the disease may become spontaneously arrested at any stage. That is, there are patients who have nothing more than evidences of upper respiratory and nasal infection, whose condition does not progress beyond that point. There are others who develop the signs of meningeal irritation, namely, headache and stiffness of the neck and back, who do not develop paralysis. Cases of this sort are spoken of as abortive poliomyelitis. Because these people are not very ill and their cases are often not recognized, they are frequently not put into quarantine and doubtless become one of the major factors in the spread of poliomyelitis to produce epidemics.

INCIDENCE AND EPIDEMIOLOGY

The following epidemiological data as they refer to the State of Minnesota have been given to me through the courtesy of Dr. Orianna McDaniel, who is the director of the Division of Preventable Diseases of the Minnesota State

Board of Health. Doctor McDaniel has permitted me to use graphs which were constructed in her division.

From 1915 to 1940 (twenty-years) there have been 6724 recorded cases in Minnesota. The greatest incidence is after one year and before five. Nursing infants are apparently protected by mother's milk. About 95 percent of the cases occur before the age of eighteen and only occasional cases are seen between the ages of forty and fifty. Practically none occur after fifty years of age. It is to be noticed that the total number of cases is a statement of the reported cases. Nobody knows how many non-paralytic and abortive cases of poliomyelitis occur, because some physicians report poliomyelitis of the non-paralytic types more or less on suspicion when they feel they have sufficient evidence to justify their diagnosis; others do not report poliomyelitis unless the patient is paralyzed. Our statistics on total case numbers are also unreliable on this account. It is probably true, though it cannot be satisfactorily proved by epidemiological statistics, that many more abortive, non-paralytic cases occur than paralytic or fatal cases. One might say, therefore, that poliomyelitis has a high infectivity rate but a low morbidity and a still lower mortality rate. Since infection by the virus, whether it produces severe or light symptoms, protects against subsequent infection, a good many more people thus develop an immunity against the virus of poliomyelitis than actually develop any serious form of the disease.

Since 1915 there have been 918 deaths in Minnesota from poliomyelitis, distributed by ages as follows:

Under fifteen years	55%
Fifteen to twenty-four years	30%
Twenty-five years and over	15%

When one compares the average of thirty-seven deaths annually due to poliomyelitis with the 644 deaths in the single year 1938 from automobile accidents in this state it is evident that the automobile is a much more serious problem from the standpoint of community welfare and health than poliomyelitis. Considering these data, the casual way with which we accept the mortality and crippling results of automobile accidents compared with the severe emotional strains that we go through in times of poliomyelitis epidemics seems somewhat contradictory.

In Minnesota eight definite outbreaks of poliomyelitis in epidemic form have occurred since 1909. It is to be observed, however, that poliomyelitis occurs also in sporadic form; that is, isolated cases are with us in the state even during the non-epidemic periods. It is interesting to note that all of the epidemics have occurred with the maximum incidence in the late summer and early autumn, as far as this state is concerned. This is also the rule in other geographical areas, but taking the world at large, there have been several epidemics which occurred in the middle of the winter. Even in non-epidemic years there is a slight increase in incidence of cases during late summer and early fall.

The close correlation between seasons of the year and epidemics has given rise to considerable speculation as to why this relationship should exist. The possibilities that flies are carriers during this time when they have their greatest

frequency or that the weather favors the spread of poliomyelitis through water or milk, or by means of vermin, such as mice and rats, or through their parasites, such as fleas and lice, have all been suggested and studied. Some evidence exists to support each of these ideas. It is generally agreed, however, that the principal mode of spread is from ambulatory infected individuals (abortive cases) through droplet infection in coughing, sneezing and talking which contaminates the air that is breathed by the next person.

The incubation period in poliomyelitis, namely, the number of days from the time of exposure to the disease to the first appearance of symptoms, is usually between six and fifteen days. However, an occasional case may not have its onset until three weeks after exposure.

THE CHANGES IN THE BODY IN POLIOMYELITIS

The disease is characterized pathologically by several features.

The lymphatic glands of the body tend to be enlarged and inflamed. This indicates that there is a generalized infection.

The really significant changes occur in the central nervous system, that is, in the brain and spinal cord. The brain is not involved to any appreciable or any serious degree except in a few cases which are commonly fatal. Certain of the brain centers which have to do with the control of respiration and circulation are sometimes severely involved; these cases usually die within a few days after the onset.

The meninges, which constitute a thin membranous envelope over the brain and spinal cord, regularly show signs of inflammation in poliomyelitis. It is this involvement which accounts for the severe headaches, the nausea and vomiting and the stiffness of the neck which is characteristic of the earlier stages of the disease. Clinically, the meningeal involvement is confirmed by examination of the spinal fluid which shows an abnormal increase in certain types of free cells that escape into the spinal fluid in the course of the meningeal reaction.

The typical nervous system injury is found in the spinal cord in paralytic cases. The gray matter (especially the anterior horns) of the spinal cord is the seat of the most severe involvement. The anterior horns contain the nerve cell bodies whose processes run out into the peripheral nerves to initiate voluntary movement in the muscles of the body. When these cells are interfered with or destroyed, paralysis of the corresponding muscle groups occurs. Inflammatory reaction, more or less nerve cell destruction, and hemorrhages into the anterior horns of the cord are characteristic of the disease microscopically.

Not all of the anterior horn cells in a given involved area are destroyed but commonly many of them are simply interfered with temporarily in their functioning; this is the explanation for the clinical observation that during the first few weeks after the acute attack, many of the paralyzed muscles can return to functioning as the surviving nerve cells in the spinal cord area to these muscles again pick up their function. After this period the slow improvement is due merely to the fact that exercise causes the remaining muscle fibers to become larger and stronger, just as an athlete's muscles do with exercise. Obviously, this improvement can only progress to a certain limit beyond which

no increase in strength becomes possible, excepting on the basis of surgical procedures which substitute the function of a neighboring unparalyzed muscle for the lost functions of the involved muscle.

THE MODERN PERIOD OF INVESTIGATION

Practically everything that has been brought out so far in this lecture excepting for the statistics and data on epidemics and incidence of the disease, was known previous to 1909. The period up to that date is spoken of as the period of clinical and pathological investigation.

In 1909, however, Landsteiner and Popper in Paris succeeded in transmitting the disease to a monkey. The method was simple. They had obtained a specimen of brain and spinal cord from a child who had died at the height of the disease. They ground up pieces of the brain and spinal cord, added some salt solution of appropriate concentration, and injected the suspension into monkeys; the animals developed the typical disease. However, they were unable to produce the disease in a second group of monkeys by injecting similar material from the first animals.

A few months later Flexner and Lewis at the Rockefeller Institute for Medical Research in New York were able to carry the disease through serial transmission in monkeys and now medicine had the virus available for work and study in the laboratory on the experimental animal. Several other investigators in different parts of the world quickly acquired the technique of Flexner and Lewis and intensive study of the laboratory disease began so that our knowledge of the characteristics of the infective agent accumulated with extreme rapidity. It was soon discovered that the virus in pieces of brain or spinal cord from infected animals could be kept for long periods of time in solutions of glycerine at ice-box temperatures. The virus could be transmitted in glycerine from one laboratory to the other so that investigators had the opportunity of working with different strains of the virus, isolated from different parts of the world, and they could check one another's observations.

It was soon demonstrated that an animal which had recovered from an attack of experimental poliomyelitis was resistant to a subsequent inoculation. This confirmed the clinical observation that an individual who had recovered from an attack was immune to subsequent attacks.

Then it was shown that virus mixed with the blood or blood serum from a recovered monkey became inactivated so that it would not produce the disease. This technique of neutralization of the virus by convalescent serum has been subsequently used as a diagnostic procedure to demonstrate the incidence of immune individuals in the general population. About 80 percent of normal adults show neutralizing substances in their blood stream against poliomyelitis. As suggested above it is assumed that this immunity has been acquired by an abortive or sub-clinical infection at some time in the individual's past.

Then it was discovered that a monkey treated with convalescent serum and injected shortly afterwards with the virus, was resistant to the virus; thus an injection of serum produces a passive immunity which lasts a short though somewhat indefinite period of time.

On the basis of these observations many attempts have been made to develop a practical means of immunizing human beings against poliomyelitis. For instance, mixtures of convalescent serum and virus have been injected into monkeys. If mixtures are used which will not occasionally produce poliomyelitis because of the overabundance of the serum, immunity is not produced. If the serum is reduced and the virus increased in proportion, then immunity is produced, but the mixture becomes dangerous because an occasional animal develops the disease. Likewise many attempts have been made to treat the virus so as to devitalize it by means of such substances as formalin, aluminum hydroxide and in the case of our own experiments (Larson and McKinley), the sodium soap of castor oil, sodium ricinoleate. All of these methods produce immunity but likewise all of them produce the disease in an occasional animal. Consequently none of them are applicable to the human being.

Attempts to produce passive immunity by the injection of convalescent serum or the serum of the child's parents (80 percent of adults are immune) during poliomyelitis epidemics have been made. The method is very cumbersome, rather expensive, and an enormous amount of work would be required to prove its efficacy. It has been used to some extent but it seems to be of limited usefulness and has not been followed up very considerably by the medical profession and health services.

Attempts to treat poliomyelitis by the injection of convalescent serum into the sick child or by transfusions of blood from convalescents to individuals who are developing poliomyelitis are theoretically entirely feasible and sound as far as the laboratory experience is concerned. In the human being, however, none of these methods has proved any more efficacious than the old symptomatic treatment that was used years ago. The trouble probably is that the case is recognized a bit too late; the treatment ought to come in the incubation period before the nervous tissue is invaded rather than at the onset of the disease.

Recently, in accord with the idea that droplet infection and spread of the infection along the olfactory nerves from the nose to the brain are the mechanisms of infection of an individual, the attempt has been made to treat the nasal passages with certain cauterizing substances with the idea of producing a dam against the spread of infection. However, rather distressing symptoms have appeared in some of these individuals after such treatment; they have sometimes lost their sense of smell and developed nasal complications. Again, since an enormous number of cases would have to be so treated in order to prove its efficacy, this method has generally been abandoned. Then, too, some workers believe that inhalation into the lungs or swallowing into the gastro-intestinal tract may really be the mechanism of invasion of the body by the virus.

In consequence, it is probably fair to say that at the present time we have no suitable method of specific control in the sense of an immunizing technique and no thoroughly satisfactory specific treatment after the disease once commences. This does not mean, however, that we are without any means of assisting in the control of an epidemic, nor that our symptomatic treatment and orthopedic aids are of no avail. Indeed, many excellent helps to the recovery of an individual are at present available. It does mean that although the specific method for control and treatment seem to be tantalizingly nearby, still much

more work will be needed before we can feel successful in a practicable approach to the eradication of this disease.

Poliomyelitis research is expensive. Monkeys cost from five to eight or ten dollars apiece and one laboratory will use several hundred animals annually. This, when added to the costs of the research assistants, attendants, and materials and equipment that must be available for the successful prosecution of experimentation in poliomyelitis, means that one laboratory would expend several thousand dollars annually in performing a very modest series of experiments.

This rather expensive experimental approach seems at the present time the most likely to yield results. We should not begrudge the annual expenditure of thousands or hundreds of thousands of dollars on this research when we think that millions are spent in the country yearly on the support and care of our cripples and when we consider the heartbreak and suffering incidental to these tragedies. There is every reason to expect that the scientist will find a chemical (similar, for instance, to sulfanilamide against the hemolytic streptococcus infections) or an immunological technique for the successful prevention or treatment of this plague. Progress in understanding has been rapid since 1909 and the possibilities of solution of the problem have been by no means exhausted.

INSTALLATION OF THE VIRGINIA POLYTECHNIC INSTITUTE CHAPTER

Sigma Xi, national honorary research society, installed its eightieth chapter at Virginia Tech, April 5, in a series of exercises whch began with a college convocation and ended with a banquet. Other events of the day, which Dr. Julian A. Burruss, president of Virginia Tech, said "will be recalled as a red or golden letter day," included a luncheon, the installation ceremony, and a reception.

The installation of the chapter of the Society of Sigma Xi took place at 3.00 o'clock with Dr. Edward Ellery, Schenectady, New York, National President of the Society; and Dr. George A. Baitsell, New Haven, Connecticut, National Secretary, in charge. Dr. B. D. Reynolds, University of Virginia, presided. The group inducted into the national organization is composed of thirty-nine members of the Tech staff who were elected members at other institutions. The petition of this group for a charter was granted at the National Convention of the Society held in Columbus last December.

DR. H. L. SHANTZ LECTURES

Dr. Homer L. Shantz, chief of wildlife management of the U. S. Forest Service and a former president of the University of Arizona, gave an illustrated address entitled "The Adjustment of Vegetation to Its Environment" at the special convocation which was held at 10.30 o'clock Friday morning, April 5, in the Administration Building auditorium. The members of the Tech Chapter of Sigma Xi, representatives of other institutions and Sigma Xi chapters, and members of the Tech faculty formed an academic procession which marched into the auditorium to a processional played by Donald A. McKibben, instructor in music at Tech. The marshal was Dr. T. W. Hatcher '22.

In opening the convocation, President Burruss, who presided, said that "this day in which a chapter of the Society of Sigma Xi is installed at the Virginia Polytechnic Institute will be recorded as one of the most important in the history of the institution."

EQUALLY IMPORTANT TO SIGMA XI

Doctor Ellery, in responding to an introduction, said that the occasion was equally as important to Sigma Xi as the organization of which he is president is desirous of being represented in institutions making important contributions in scientific investigation and research. Doctor Baitsell also responded briefly to an introduction. The invocation and benediction were pronounced by the Rev. Richard S. Martin, rector of the Christ Episcopal Church, Blacksburg.

The Society of Sigma Xi was founded at Cornell University more than fifty years ago by engineering graduate students, Doctor Ellery explained at the luncheon which was held in the Faculty Center. It is now the largest scientific organization in the world and has grown to that position, he said, because it has always fostered the right ideals. Essentially it has always been a "youth

movement," he continued, because it has sought to recognize young men who are doing research work of great promise. The national program of the organization includes, among other things, the awarding of research prizes and grants-in-aid to research workers. In recent years it has selected five men noted in their fields of scientific research to give lectures at various places in the country. The lectures over a two-year period have been compiled in a book entitled "Science in Progress," written in language that the layman can comprehend. A second volume covering a second period of two years is now being edited by Doctor Baitsell.

CAMPUS GROUPS BRING GREETINGS

Greetings from the other honorary fraternities on the Virginia Tech campus were briefly expressed by their presidents: Prof. C. P. Miles '01, Phi Kappa Phi; W. B. McSpadden, Alpha Zeta; N. N. Ripley, Pi Delta Epsilon; R. V. Allen, Phi Lambda Upsilon; C. G. Armfield, Tau Beta Pi; W S. Holland, Jr., Omicron Delta Kappa; W. P. Glover, Scabbard and Blade; and R. T. Priddy, Alpha Kappa Psi.

Two distinguished scientists—Dr. Robert A. Hopper and Dr. E. H. Hopper—briefly responded to introductions. The former was introduced by Dr. R. J. Holden and the latter by Dr. S. A. Wingard. Dr. Paul R. Burch brought greetings from Radford State Teachers' College. Col. Earle B. Norris, dean of engineering at Virginia Tech, presided at the luncheon which was attended by nearly 100 persons.

TECH CHAPTER'S OUTLOOK BRIGHT

The outlook for the Virginia Tech Chapter is unusually bright, Doctor Baitsell said at the banquet which was attended by about 125 persons. Something of the future of the national organization was touched upon. He pointed out that additional grants-in-aid and the establishment of Sigma Xi fellowships with large enough stipends to attract young outstanding scientific workers were being planned. Enlargement of the lectureship plan to include more time for conferences at the institutions at which the lecturers visit; expansion of the QUARTERLY; more emphasis on the books, "Science in Progress," and the distribution of such publications to libraries of small colleges were other avenues of national development Sigma Xi is considering.

Virginia Tech has been interested in research for more than fifty years with the establishment of the Virginia Agricultural Experiment Station here in 1888, Doctor Burruss said at the banquet. The engineering experiment station was established by the board of visitors in 1921 and other departments and individuals also are conducting research.

RESEARCH ENCOURAGED

The administration, he continued, has tried to encourage all members of the faculty to engage in some research as it has felt that good teachers should do some research. The spirit of research—advancing the frontiers of knowledge—is essential to a good teacher. Tech has now available annually more than $325,000 for conducting research. "We are seeking earnestly," he pointed out, "to avoid duplication with others. We are primarily interested in the appli-

cation of science in agriculture and industry." He expressed the feeling that Sigma Xi will encourage research at V. P. I.

Doctor Ellery expressed the view that Sigma Xi is a movement that is never static. It must always grow. He illustrated that point by quoting Doctor Whitney, who recently retired as head of research of the General Electric Company, as saying that the "only perpetual motion known to man is the growth of truth." Scientists are never satisfied, Doctor Ellery said. "The urge to know on the part of the human mind," he concluded, "is the principal object of Sigma Xi."

OTHERS EXPRESS GOOD WISHES

Dr. John E. Williams, dean of the college, congratulated the Tech Chapter for obtaining the Sigma Xi charter and the national officers for "knowing a good thing when they see it."

Dr. J. George Harrar, associate professor of biology at Virginia Tech, read messages of congratulations from other institutions and from other Sigma Xi chapters. He then introduced representatives of other chapters who were present. Those who expressed greetings included: Dr. J. H. Yoe, University of Virginia; Dr. C. E. White, University of Maryland; Dr. John McGraw, representing Johns Hopkins University; Dr. I. D. Wilson, representing Pennsylvania State College; Dr. L. D. Keyser, Roanoke physician, representing the Mayo Foundation, University of Minnesota; Dr. B. D. Reynolds, University of Virginia; Dr. C. L. Shear, charter member of the University of Nebraska Sigma Xi Chapter and father of Dr. G. M. Shear, assistant plant pathologist of the Virginia Agricultural Experiment Station. Mrs. C. L. Shear also was presented. Dr. Hugh Trout, Roanoke physician, representing the Johns Hopkins Chapter, and Col. William E. Byrne, representing V. M. I., were mentioned as having been at some of the exercises during the day, but were unable to remain for the banquet.

APPRECIATION FOR AID EXPRESSED

Doctor Shantz, the convocation speaker, brought greetings on behalf of Phi Kappa Phi, honorary scholarship fraternity, of which he had been national president from 1935 to 1939.

Dr. P. C. Scherer, Jr., president of the Virginia Tech Chapter of Sigma Xi, in presenting Dr. Ivey F. Lewis, dean of the University of Virginia, as toastmaster for the banquet, expressed appreciation to the committees for making the day a success and to President Burruss for "his aid and inspiration during the years in which a charter had been sought."

Mrs. F. W. HofMann, accompanied by Dr. F. B. Haynes, sang two solos. Dinner music was furnished by the Blacksburg-V. P. I. ensemble under the direction of Doctor HofMann.

Administration officials, officers of the Virginia Tech Sigma Xi Chapter and their wives were in a receiving line at a reception for the installing officers and visiting delegates at 4.00 o'clock in the Faculty Center. Members of the Blacksburg Branch of the American Association of University Women assisted. —*From April 15 Telegram.*

MINUTES OF THE MEETING OF THE EXECUTIVE COMMITTEE OF SIGMA XI, APRIL 24, 1940, WASHINGTON, D. C.

A stated meeting of the Executive Committee was held in the Cosmos Club in Washington, D. C., April 24, 1940. The meeting was called to order by President-elect Ellery, at 2.00 P.M. Present were: President-elect Ellery, Secretary-elect Baitsell, Treasurer Pegram, Professor Lund, Professor Shapley, Professor Anderson, Doctor Jordan, Doctor Durand, Doctor Utley; and, by invitation, Mr. Davis from Science Service, and Doctor Moulton from the A. A. A. S. The following business was transacted:

1. PUBLICATION OF ANNUAL ADDRESS:

The acting secretary announced that Doctor Mather's lecture at the 1939 Convention had been sent, at their request, to the *Scientific Monthly* and *Scientific American* for publication simultaneous to its appearance in the Spring issue of the QUARTERLY. Due credit to the Society was given in these periodicals, but *Science Digest* published a "digest" with credit only to the *Scientific Monthly* and without reference to Sigma Xi. Publication rights were not given to *Science* on the ground that the address could not appear prior to QUARTERLY publication.

The question of what our policy should be was discussed at some length, and it was

Voted: That publication of the annual address should be reserved exclusively for Sigma Xi; and that if we grant to the *Scientific Monthly* the right to publish after its appearance in the SIGMA XI QUARTERLY, the *Scientific Monthly* must state that permission to publish has been granted by Sigma Xi.

2. INSTALLATION AT VIRGINIA POLYTECHNIC INSTITUTE:

Professor Ellery reported that Professor Baitsell and he had served as installing officers at the installation of the Virginia Polytechnic Institute Chapter at Blacksburg, Virginia, on April 5.

3. REPORTS OF OFFICIAL VISITORS:

a. Oberlin College:

The report of the official visit of Professor Cole and Doctor Myers to Oberlin was presented at the December, 1939, meeting of the Executive Committee. Because of lack of time, Oberlin was made a definite item of business for the Spring meeting. The report of the official visitors was reviewed, and after some discussion it was

Voted: That the group at Oberlin College be asked to present a formal printed petition for consideration of the committee at the December, 1940, meeting.

b. Bryn Mawr College:

The committee felt that there was no question but that the group at Bryn Mawr was ready for a chapter. It was

Voted: That the science group at Bryn Mawr should be asked to take the next step in the procedure for securing a charter for a chapter, namely, to present a formal printed petition for the consideration of the committee at its December meeting.

4. Reports of Unofficial Visitors:

a. Utah State Agricultural College:

Professor Anderson reported that he would visit the Utah State Agricultural College on his way back to Pasadena from Washington, and would send a written report of his visit to the acting secretary for distribution among the members of the Executive Committee.

b. University of Vermont:

Professor Ellery reviewed the report of his visit, presented to the Executive Committee at the December, 1939, meeting and on which action was postponed, and after discussion it was

Voted: That the President be authorized to appoint an official visitor to the University of Vermont.

c. Texas Technological College:

Professor Lund presented the report of his visit to the Texas Technological College. After considerable discussion, the committee

Voted: That action in connection with a possible petition for a charter for a chapter at the Texas Technological College be deferred.

5. Additional Information about Institutions:

a. Armour Institute of Technology:

Additional information about the Armour Institute of Technology was presented, and the situation at the Institute was reviewed. After some discussion, it was

Voted: That the President be authorized to appoint someone from the Chicago or Northwestern Chapter to make an unofficial visit to the Armour Institute of Technology, for report at the December meeting of the Executive Committee.

b. Louisiana State University:

At the April, 1939, meeting of the Executive Committee, it was voted that no action should be taken regarding a possible petition from the group at Louisiana State University for one year. When the institution was brought up at the present meeting it was

Voted: That, in the absence of additional information, further action with regard to the situation at Louisiana State University be deferred.

6. Officers' Visits to Chapters:

At the December, 1939, meeting the Executive Committee suggested that the matter of officers' visits to chapters be brought up at this Spring, 1940, meeting. The acting secretary stated that such meetings with national officers would

consist of informal conferences with local chapter officers, or informal visits at previously arranged meetings of the chapters. The acting secretary suggested that since he is retiring from academic duties this June, he would be free to make such visits. After some discussion, it was

Voted: To refer to the President, Secretary, and Treasurer the question of officers' visits to chapters.

7. QUARTERLY:

The 1939 Convention of the Society approved the recommendations of the Executive Committee regarding the immediate future of the QUARTERLY. The acting secretary stated that the question must be decided as to how the policy should be put into effect with the issuance of the Autumn number, which would appear sometime in September. For the time being, the Secretary of the Society is to serve as Editor-in-Chief of the QUARTERLY, with an editorial board to consist of three advisory editors, and twelve associate editors.

The acting secretary stated that the proposed policy of definite arrangement for QUARTERLY articles in advance would not contemplate any present enlargement of the journal, or any additional expense. The opinion was expressed that the QUARTERLY could not be enlarged or improved to any great extent without considerable increase in expense of publication.

8. CIRCULATION OF ALUMNI:

This item of business called forth a good deal of comment. Many ideas were expressed, and after full and lengthy discussion, it was

Voted: That the movement of circularizing the alumni should be continued this year.

9. GRANTS-IN-AID OF RESEARCH:

Since the amount which would accrue from the 1940 circularization of alumni was so uncertain, it was

Voted: To authorize the President, Secretary, and Treasurer to determine the amount to be expended for grants-in-aid in addition to the sum which the Treasurer will inform the committee will be available for the purpose.

10. FUNDS FOR PUBLICITY:

The acting secretary announced that at the December, 1939, meeting the Executive Committee had voted an appropriation of $100 to be used for publicity until the adoption of the budget for the year 1940. After some discussion, it was

Voted: That a total of $200 be allotted to Science Service for publicity for the year 1940.

11. DISTRIBUTION OF "SCIENCE IN PROGRESS":

At the December, 1939, meeting of the Executive Committee, the acting secretary was asked to obtain from the deans of a number of graduate schools in the country the names of small institutions from which those graduate schools

have received successful graduate students in science, with the idea that the distribution of "Science in Progress" to such small institutions would be one way in which the Society might aid in the "promotion of research." The acting secretary announced that in reply to his request to various deans, a considerable list of small institutions has been assembled. It was

Voted: That the acting secretary be authorized to send letters to the heads of the science department of these small institutions, incorporating the following questions: (1) Does your library have a copy of "Science in Progress"? (2) If you are given a copy of "Science in Progress" to be placed in your library, or among departmental books, would it be used to advantage by your students?

It was also

Voted: That the distribution of "Science in Progress" to these institutions should not exceed twenty-five copies.

12. Distribution of "Half Century History and Record":

The acting secretary announced that there are some 700 volumes of the "Half Century History and Record" on hand, some of which it might be well to distribute before the office is moved to New Haven.

It was suggested that the acting secretary might recommend to chapters, if they have not already done so, that they present a copy of the "Half Century History and Record" to the library of their respective institutions.

It was

Voted: That the Society should distribute to each chapter and club a copy of the "Half Century History and Record," such copies to have stamped on the outside cover the appropriate inscription, "Property of the Sigma Xi Club," or "Property of the Sigma Xi Chapter."

It was also

Voted: To send out for publicity purposes up to twenty copies of the "Half Century Record and History," Mr. Davis of Science Service to supply the acting secretary with a list of individuals and draft of letter.

13. Expenses of the Executive Committee at the December Meeting, and Time Allotted to Such Meeting:

The acting secretary reviewed the policy of the society with regard to expenses of the members of the Executive Committee, as follows: The full expenses of the members of the committee are met by the Society at the April meeting. One-half the minimum railroad fare of those attending the December meeting of the Executive Committee is met by the Society. The question of whether the time is not now ripe for the Society to meet the full expenses of the members of the committee at both meetings was discussed at length.

At the same time the problem of time allotted to the December meeting of the Executive Committee was discussed. The acting secretary brought to the attention of the committee the fact that much important business has to be post-

poned to the April meeting because of lack of time, and that the short time at the disposal of the committee at the December meeting is entirely inadequate.

After considerable discussion, it was

Voted: That the acting secretary appoint a committee to study the problems of expenses of the Executive Committee at the December meeting, and the time allotted to such meeting.

14. Budget for 1940:

Treasurer Pegram presented the following proposal for the 1940 budget:

1.	Secretary's office:	
	(a) salaries, clerical assistance	$ 4,400
	(b) postage, express, telegrams, stationery, supplies, etc.	700
	(c) circularization of alumni for research contributions	600
	(d) moving office from Schenectady to New Haven	200
2.	Treasurer's office	240
3.	Officers' travel expenses	1,700
4.	Quarterly (four issues)	3,600
5.	Engrossing Charters	200
6.	Travel expenses of Sigma Xi lecturers	1,700
7.	Science Service (for publicity)	200
8.	Extra copies "Science in Progress"	60
	Total	$13,600

It was

Voted: To adopt the budget for 1940 as proposed.

15. Report of the 1941 Lecture Series:

The acting secretary announced that the following individuals had accepted appointments as lecturers in the 1941 series:

Dr. James Franck, University of Chicago—"Fundamentals of Photosynthesis."
Perrin H. Long, M.D., Johns Hopkins Hospital—"Recent Advances in Bacterial Chemotherapy, with Special Reference to the Mode of Action of Sulfanilamide and Its Derivatives."
Dr. I. I. Rabi, Columbia University—"Radio Frequency Spectra and the Magnetic Properties of Atomic Nuclei."
Dr. Harlow Shapley, Harvard College Observatory—"In Defense of the Universe" (or, "Galactic Explorations").
Dr. V. K. Zworykin, Director, Electronic Research Laboratory, RCA Manufacturing Company, Inc.—"Image Formation by Electrons."

16. Participation of Clubs in Affairs of the National Society:

The acting secretary reported that under the present policy of the Society the various clubs and their officers are listed in the Quarterly, and each year the club secretaries send to the national office a report of their activities. There is no record on the national files of the membership of such clubs. The question of possible assessment for each club member (such members to be reported to the National Secretary, and each to receive the Quarterly) was brought up. After a good deal of discussion, it was

Voted: That the Executive Committee present to the 1940 Convention the question of possible annual assessement of 50 cents for each club member (to include receipt of the Sigma Xi Quarterly).

17. FINANCIAL ADVISORY COMMITTEE:

Treasurer Pegram had reported to the acting secretary the death of Mr. Roger B. Williams, Jr., a member of the Financial Advisory Committee. The committee

Voted: To authorize the Treasurer to recommend a new member of the Financial Advisory Committee.

18. EIGHTH AMERICAN SCIENTIFIC CONGRESS:

The acting secretary announced that the Society of the Sigma Xi had been invited to participate in the Eighth American Scientific Congress to be held in Washington, May 10-16. After some consideration, it was

Voted: That the President be empowered to appoint a total of six delegates to represent the Society of the Sigma Xi at the Eighth American Scientific Congress.

19. 50TH ANNIVERSARY OF FOUNDING OF KANSAS CHAPTER:

The acting secretary announced that the Society of the Sigma Xi had been invited to be represented at the 50th anniversary of the founding of the Kansas Chapter. The acting secretary sent a letter of congratulation to the Kansas Chapter, and had invited Professor Stadler of the University of Missouri to represent the Society if he planned to attend.

20. DISCREPANCIES IN THE CONSTITUTION:

The attention of the Executive Committee was drawn to the fact that there was a discrepancy in the Constitution as between Article II, Section 3, and Article IV, Sections 3 and 4. It was

Voted: To postpone action until the Committee on Membership Structure had made its report.

21. COMMITTEE ON MEMBERSHIP STRUCTURE:

A report of progress was presented by the Committee on Membership Structure. It was

Voted: To authorize the acting secretary to write chapters electing members and associates from other than recognized fields as follows: "We note that the following individuals were elected to your chapter in fields outside those recognized by the national organization. It is my duty to inform you that on the basis of the action of the 1929 Convention, these men cannot be recognized as members of Sigma Xi."

22. ADJOURNMENT:

The meeting was adjourned at 10.30 P.M.

EDWARD ELLERY, *Acting Secretary.*

CHAPTER OFFICERS

List Furnished by the Secretaries of the Chapters

Chapter	President	Vice-President	Secretary
Cornell	J. M. Sherman	C. C. Murdock	L. Spencer
Rensselaer	G. H. Carragan	P. E. Hemke	E. J. Kilcawley
Union	F. J. Studer	E. M. Ligon	A. H. Fox
Kansas	H. B. Hungerford	A. W. Davidson	W. H. Schoewe
Yale	E. J. Miles	F. T. McNamara	L. F. Nims
Minnesota	E. T. Bell	E. W. Davis	E. A. Donelson
Nebraska	M. G. Gaba	J. E. Weaver	E. R. Washburn
Ohio State	L. H. Snyder	G. A. Stewart	P. B. Stockdale
Pennsylvania	D. H. Wenrich	J. H. Austin	R. Morgan
Brown	R. B. Lindsay	Z. R. Bliss	P. H. Mitchell
Iowa	E. W. Chittenden	E. Bartow	D. Lewis
Stanford	L. M. Terman	G. S. Parks	K. M. Cowdery
California	C. D. Shane	H. Kirby	L. E. Reukema
Columbia	A. W. Thomas	H. B. Williams	D. P. Mitchell
Chicago	D. B. Phemister	R. T. Chamberlin	V. E. Johnson
Michigan	H. H. Willard	M. H. Soule	F. L. Everett
Illinois	B. S. Hopkins	N. E. Stevens	P. W. Ketchum
Case	F. Whitacre	R. Shankland	R. L. Burington
Indiana	R. J. Hartmann	R. E. Esarey	M. L. Lohman
Missouri	W. D. Keller	R. T. Dufford	B. Bennitt
Colorado	I. C. Hall	W. Thompson C. A. Rymer	H. Hoffmeister
Northwestern	C. H. Behre, Jr.	A. C. Ivy	N. C. Jamison
Syracuse	V. F. Lindeman	N. E. Artz	J. Russell
Wisconsin	L. R. Ingersoll	R. A. Brink	J. G. Winans
Univ. of Wash.	T. G. Thompson	J. I. Rowntree	Rex Robinson
Worcester	A. H. Holt	H. B. Feldman	W. E. Lawton
Purdue	H. R. Kraybill	G. A. Hawkins	R. C. Corley
Washington Univ.	A. S. Gilson	P. R. Rider	Florence M. Heys
Dist. of Columbia	O. H. Gish	O. S. Adams	S. F. Blake
Texas	Duncan McConnell	A. E. Lockenvitz	G. H. Fancher
Mayo Foundation	W. D. Shelden	R. M. Wilder	E. V. Allen
N. Carolina	H. D. Crockford	J. W. Huddle	J. E. Magoffin
N. Dakota	E. O. North	C. R. Byers	A. R. Oliver
Iowa State	C. Y. Cannon	J. M. Aikman	D. L. Holl
Rutgers	D. L. Cottle	W. R. Robbins	Mrs. F. T. Starkey
McGill	B. P. Babkin	T. H. Clark O. Maass	R. V. V. Nicholls
Kentucky	M. M. White	O. Koppius	L. H. Townsend
Idaho	H. S. Owens	J. Ehrlich	G. Woodbury
Swarthmore	R. B. MacLeod	E. H. Cox	H. J. Creighton
Oregon	A. H. Kunz	W. R. Todd	K. S. Ghent
Virginia	G. T. Whyburn	J. E. Kindred	J. K. Roberts
Johns Hopkins	J. C. Hubbard	Ernst Cloos	M. W. Pullen
Calif. Inst. of Technology	W. V. Houston	C. B. Millikan	J. van Overbeek
New York	H. A. Taylor	W. F. Ehret	F. E. Myers
Cincinnati	G. E. Cullen	F. O'Flaherty	S. B. Arenson
Mich. State	C. A. Hoppert	P. J. Schaible	F. C. Strong
Arizona	E. H. Warner	M. N. Short	F. E. Roach
Lehigh	H. A. Neville	C. A. Shook	C. D. Jensen
Maryland	C. E. White	R. G. Rothgeb	R. Bamford
Kansas State	R. C. Smith	A. B. Cardwell	G. A. Filinger
Col. of Medicine Univ. of Illinois	W. H. Welker	I. Pilot	I. Schour
Pennsylvania State	R. D. Anthony	F. Stewart	F. G. Merkle
Oklahoma	C. A. Merritt	D. Young	M. Hopkins
State Col. of Wash.	J. Sotola	N. S. Golding	O. Biddulph
Wyoming	C. S. Gilbert	W. B. Owen	F. C. Freytag
Rochester	B. O'Brien	E. Adolph	K. U. Smith
Pittsburgh	O. H. Blackwood	F. C. Jordan	A. E. Staniland
Harvard	C. H. Berry	C. F. Brooks	F. M. Carpenter
Western Reserve	T. J. Hill	F. J. Bacon	J. C. Gray
Princeton	A. M. Greene	E. G. Butler	H. N. Alyea
Duke	W. J. Seeley	J. J. Gergen	C. G. Bookhout
California At Los Angeles	W. J. Miller	F. S. Fearing	M. S. Dunn
Massachusetts Inst. of Technology	S. C. Prescott	W. C. Voss	A. A. Ashdown

CHAPTER OFFICERS—*Continued*

Chapter	President	Vice-President	Secretary	Treasurer
	W. L. Duren, Jr.	Charlotte H. Boatner	H. Cummins	H. Cummins
	H. B. Goodrich	F. Slocum	J. W. Peoples	J. W. Peoples
	R. F. Collins	N. M. Mohler	L. T. Slocum	E. J. Gibson
	L. M. Gould	C. A. Culver	C. H. Gingrich	C. H. Gingrich
	G. H. Cartledge	G. E. Youngburg	M. C. Swisher	H. F. Montague
Washington	J. H. Roe	D. B. Young	C. E. Leese	Florence M. Mears
	M. B. Hogan	H. Schneider	J. R. Lewis	J. R. Lewis
Inst. of logy	J. B. Rosenbach	C. R. Fettke	H. C. Howard	R. T. Gabler
State	J. E. Simmons	H. A. Scullen	W. D. Wilkinson	G. W. Gleason
	A. C. Chandler		G. H. Richter	J. H. Pound
etts State	H. Van Roekel	C. P. Alexander	Helen S. Mitchell	W. H. Ross
	Ruth Johnstin	M. J. Zigler	H. W. Dodson	H. W. Kaan
	C. F. Byers	R. B. Becker	L. M. Thurston	D. Williams
rginia	A. M. Reese	O. Rex Ford	C. L. Lazell	J. H. Gill
	E. B. Carmichael	J. D. Mancill	E. B. Richards	B. W. Gandrud
technic Inst.	P. B. Scherer	F. B. Haynes	W. J. Schoene	J. A. Addelstone

SIGMA XI CLUBS

Club	President	Vice-President	Secretary	Treasurer
California	R. W. Truesdail		F. M. Baldwin	J. A. Hartley
enver	B. Cohn		Margaret Boos	Margaret Boos
ine	E. R. Hitchner	W. E. Bradt	B. Speicher	B. Speicher
State M. College	N. A. Christenson	D. F. Costello	Ruth Sumner	Ruth Sumner
State U.	R. L. Menville	L. W. Morris	H. J. Bennett	H. J. Bennett
kansas	W. S. Dyer		W. R. Horsfall	W. R. Horsfall
ty of t Davis	G. A. Richardson		T. H. Jukes	T. H. Jukes
iversity	W. W. Atwood		P. M. Roope	P. M. Roope
s Univ.	D. W. MacCorquodale	L. F. Yntema	A. E. Ross	
onnecticut	W. L. Kulp	F. Heiser	H. W. Hunter	H. W. Hunter
iversity	W. H. Shideler		R. V. Van Tassel	R. V. Van Tassel
orgia	D. C. Boughton		G. W. Crickmay	G. W. Crickmay
University	W. D. Garman		J. D. Stetkewicz	
A. and ege	Daisy I. Purdy	A. H. Kuhlman	J. E. Webster	J. E. Webster
State Coll.	D. B. Swingle	H. T. Ward	P. L. Copeland	P. L. Copeland
kota College	J. A. Munro	R. E. Dunbar	J. A. Ord	J. A. Ord
ech. Coll.	W. M. Craig	E. L. Reed	W. W. Yocum	
ntana	F. O. Smith	G. D. Shallenberger	C. W. Waters	
China	K. P. Young	H. C. Chang	P. P. T. Sah	P. P. T. Sah
	W. A. Ver Wiebe	C. C. McDonald	E. A. Marten	E. A. Marten
iversity	D. B. Green	C. L. Dow	A. C. Anderson	A. C. Anderson
w Mexico	R. E. Holzer	G. V. Martin	L. S. Gill	L. S. Gill
nsas City	Grant Smith	K. L. Mahony	C. W. Sondern	C. W. Sondern
ic Institute oklyn	R. E. Kirk	C. C. Whipple	W. H. Gardner	W. H. Gardner
e Univ.	H. P. Pettit	D. R. Swindle	J. F. H. Douglas	
ate	Mary Pinney		M. J. Martin	
stitute	M. A. Countryman	B. S. Radcliffe	L. T. Anderson	D. L. N. Hedrick
pi	F. M. Hull	A. B. Lewis	G. W. Parsons	G. W. Parsons
	R. G. Daggs	C. E. Braun	P. A. Moody	P. A. Moody
Agr. Coll.	L. B. Linford	G. F. Knowlton	L. E. Malm	L. E. Malm
Young ity	J. K. Nicholes		M. Marshall	M. Marshall
lege	C. Welty		N. Bennington	N. Bennington
Poly. Inst.	W. D. Salmon	G. Volk	J. R. Jackson	
iversity	O. R. Quayle	J. H. Purks	E. Papageorge	W. B. Redmond
State College.	Z. P. Metcalf	W. H. Browne	R. C. Bullock	R. C. Bullock
	C. J. Hamre	M. Potgieter	S. S. Ballard	S. S. Ballard
pi State	C. Q. Sheely	C. H. Ragland	F. P. Welch	F. P. Welch
vada	Harry Wheeler	S. W. Leifson	W. D. Billings	W. D. Billings

OFFICIAL ANNOUNCEMENTS

SIGMA XI EMBLEMS

All insignia of the Society are available only through the office of the National Secretary. They are made in various styles and sizes, and in white and yellow gold. Orders for these insignia are issued through chapter secretaries, and must be *prepaid*. Information about styles and prices may be obtained from chapter secretaries or the National Secretary.

DIPLOMAS FOR MEMBERS AND ASSOCIATES

These diplomas are available in any quantity at 10 cents each. Diplomas can be engraved with the name of the individual and of the chapter and the date of initiation at 25 cents each. Orders should be sent to the National Secretary, should specify whether for members or associates, and should be accompanied by check.

INDEX CARDS

Index cards for newly elected members and associates are available *gratis* upon requisition from chapter secretaries to the National Secretary. These cards should be made out in duplicate, one set being retained for chapter files and one set being sent to the National Secretary for filing in the permanent records of the national organization.

NATIONAL CONSTITUTION

Printed copies of the National Constitution and History of the Society are available at 5 cents each from the National Secretary.

CHANGES OF ADDRESSES

Chapter secretaries are asked to send to the National Secretary in October of each year changes in their enrollment lists as follows: 1. Names and addresses to be deleted from the previous list; 2. Names and addresses to be added to previous list; 3. Changes of addresses of those on previous list who may have moved to a new address since the list was submitted.

SIGMA XI STATIONERY

Stationery in the official color of the Society is now available for all chapters and clubs at \$5 per 500 sheets and \$5 per 500 envelopes. The letter sheets bear the Society's seal embossed in white but no printing. The envelopes are the official square envelopes used by the national officers. Printed heading on the sheets and printed corner cards on the envelopes can be provided at cost, when so desired.

EDWARD ELLERY,
National Secretary, Sigma Xi,
Union College,
Schenectady, N. Y.